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Bulletin No. 7. By Otto H. Swezey. Army Worms and Cutworms on Sugar Cane in the Hawaian Islands. 31 pages. 3 plates. (Nov., 1909.)

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Bulletin No. 12. By G. W. Kirkaldy and F. Muir. On some New Species of Leaf-Hoppers. 85 pages. 3 plates. (January, 1913.)

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CORRECTIONS

In the Hawaiian Sugar Planters' Entomological Bulletin I, part 9, and Bulletin III, a number of references in the texts to figures have been wrongly quoted although the correct names are given under "Description of Plates." This has led to some confusion in certain cases. To avoid this the following list of corrections is given:

BULLETIN NO. 1, PART 9.

Page 320 line 26 insert "Pl. XXX fig. 1" after "sp. nov."
Page 338 line 21 delete "Pl. VII figs. 1, 2."
Page 343 line 28 insert "Pl. XXXI fig. 7."
Page 359 line 14 insert "Pl. XXII fig. 12; Pl. XXXI figs. 2, 3."
Page 385 line 9 read "Pl. XXIII" for "Pl. XXXIII."
Page 385 line 10 insert "Pl. XXXII fig. 5."
Page 416 line 3 read "Pl. XXVIII" for "Pl. XXVII."
Page 427 line 32 read "figs. 3, 4" for "figs. 5, 6."
Page 462 line 35 insert "Pl. XXIII figs. 9-11; Pl. XXXI fig. 1."

BULLETIN NO. III.

Page 77 line 32 insert "Pl. II figs 16, 17."
Page 100 line 9 read "Pl. V" for "Pl. III"; line 12 read "7, 8, 11" for "7, 8."
Page 112 line 15 read "Pl. VIII figs. 19-21" for "Pl. XXVII, figs. 9, 21."
Page 119 last line read "Pl. IX" for "Pl. VII."
Page 132 line 25 read "Pl. XIII" for Pl. XII."
Page 134 line 21 read "Pl. XI" for "Pl. VIII"; line 35 read "Pl. XIII" for "Pl. XII."
Page 135 line 4 from bottom read "Pl. XII" for "Pl. XIII" and insert "Pl. XI figs. 14-16."
Page 137 line 9 read "Pl. XIII" for "Pl. XII"; line 15 read "Pl. XI" for "Pl. VIII"; "Pl. XIII" for "Pl. XII"; line 25 read "Pl. XIII" for "Pl. XII"; line 31 read "Pl. XII" for "Pl. X."
Page 138 line 11 read "Pl. XII" for Pl. X."
Page 140 line 21 insert "Pl. XII figs. 10, 11."
Page 146 line 34 read "Pl. XVII" for "Pl. XVI."
Page 154 line 10 read "Pl. X" for "Pl. XX."
Page 165 last line insert "tegmen and wing text figures 3, 3a p. 166."
Page 166 line 15 delete "Pl. XIX fig. 20." The text figures 3, 3a are of "Suva koebelei," not "Basileocephalus."
Page 173 line 10 insert "Pl. XVIII figs. 5, 7."
Page 177 line 18 insert "Bull. I" after Kirk.
Page 179 last line but one insert "12, dorsal view of head and thorax."
Page 183 line 4 from bottom read "*Perkinsiella*" for *Dicranotropis*" (this species has since been removed to *Dicranotropis*).

ERRATA BULLETIN NO. 11.

Page 38 line 1, for "(3)" read "(2)."
Page 38, line 8, following this a line is omitted, viz: "Habitat: Telock Ayr, W. Borneo."
Page 46 line 9, for "D" read "K."
Page 65 line 15, for "Loemelicharia" read "Leomelicharia."

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DIVISION OF ENTOMOLOGY BULLETIN NO. 6.

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

The Hawaiian Sugar Cane Bud Moth (*Ereunetis flavistriata*) With an Account of Some Allied Species and Natural Enemies.

BY OTTO H. SWEZEY

HONOLULU, HAWAII
OCTOBER 25, 1909

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the Hawaiian Sugar
Planters' Association, Honolulu, Hawaii.

GENTLEMEN:—I herewith submit Bulletin VI of the Division of Entomology. It has been prepared by Mr. Otto H. Swezey, and is entitled "The Hawaiian Sugar Cane Bud Moth (*Ereunetis flavistriata*), with an Account of some Allied Species and Natural Enemies."

Yours obediently,

G. W. KIRKALDY,
Acting Director, Division of Entomology.

Honolulu, Hawaii, August 2, 1909.

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INTRODUCTION.

The bud moth (*Ereunetis flavistriata*) is apparently not a native insect, although it is not at present known elsewhere. It is an example of an insect of other habits becoming attached to an introduced cultivated plant, i. e., sugar cane. It is always to be found in the cane fields of the Hawaiian Islands, and usually very numerous; but it also retains its habits of feeding on various other plants. It is usually not particularly injurious, as it customarily feeds on the dead and drying tissues of the leaf sheaths of sugar cane; but when very numerous and on particularly soft varieties of cane the caterpillars do considerable eating of the epidermis, and also eat into the buds and destroy them, occasioning a good deal of loss where the cane is desired for cuttings to plant.

Associated with this species are often also the caterpillars of several other species of moths, some of which feed in dead cane sticks or in the tunnels of the cane borer (*Sphenophorus obscurus*) as well.

This bulletin treats of the habits of the bud moth and its lepidopterous associates, and also their parasites so far as any are known.

Of the twenty or more species of *Ereunetis*, very little is known regarding their habits. They are distributed from West Indies to Marquesas, Fiji, Hawaii, New Zealand, Australia, India, and Ceylon; but there are only two species which are known from more than one locality: *minuscula* in West Indies and Hawaii; *simulans* in Hawaii, Marquesas, Fiji, and Ceylon. Aside from the species herein treated, one species (*iuloptera*) in Australia has been bred from a pupa in bark of a fibrous-barked species of Eucalyptus (Meyrick).[1] An Indian species (*seminivora*) was bred from a pod of *Cassia occidentalis* (Walsingham).[2] This is in accord with the habits of our species; for of our five species, *simulans* feeds on bark and wood of dead trees; *minuscula* in dead wood and pods of various leguminous trees and plants; *flavistriata* on dead leaves, etc., of sugar cane, palms, and various other plants. It is probable that when the habits of other species of the genus are studied, they will be found quite similar.

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[1] P. L. S., N. S. W., V, p. 260, 1881.

[2] Indian Museum Notes, IV, p. 107, Pl. VII, Fig. 2, 1899.

The same can be said for the genus *Opogona.* About two dozen species are known, but the habits of only a few of them are known. In Java, caterpillars of *dimidiatella*[3] feed on sugar cane, eating the surface of the young roots at the base, causing them to die. They also sometimes enter the passages of the borers; but chiefly live on dead tissues; hence, are not particularly injurious, especially as they are not numerous. In New Guinea, *saccharella* has similar habits to the above. In Java, *fumiceps*[4] is reported as feeding on the coconut palms. In Mauritius, *subcervinella*[5] is reported to feed on sugar cane, potatoes, and other stored tubers. The larva of *lachanitis*[6] was found feeding in the fungus beds of the common termite, in Ceylon. Our two species both feed in dead sugar cane, rotten wood, and various other decaying substances.

I have included four species of moths sent by Mr. Muir from New Guinea, where their larvae feed in cane similarly to the way that some of our species do here. Of these moths, two species are *Ereunetis* (both new species), and two are *Opogona* (one new species). I have included them, as it is a matter of considerable interest to know that elsewhere some of the species of these two genera have the same habits that the Hawaiian species have. I have no doubt but that when the habits of those species of these genera whose habits are at present unknown, are studied, they will be found to be quite similar to those already known.

Habits of the other genera herein treated are mostly as little known. *Cryptoblabes* has about a dozen species. Of these, in Europe, the larva of *bistriga*[7] feeds in folded leaves of oak and alder. I have found nothing published in regard to habits of other species.

Of *Batrachedra,* more is known, for discussion of which see under *B. rileyi,* page 23 of this bulletin.

There is very little parasitization of any of these species of moths so far as I have been able to observe. Probably of the few treated of in this paper none are of any special importance, tho one or two of them were found locally quite abundant at one time on the bud worm, yet there was no appreciable diminution in their numbers.

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[3] Van Deventer, Hanboek ten dienste van de Suikerriet-cultur en den Rietsuiker-fabricage op Java, II, p. 165, Pl. 22, Fig. 12, 1906.

[4] Van Deventer, Tijd. Ent., XLVII, p. 83-84, Pl. X, Figs. 1a, 1b, 1904.

[5] Walsingham, Fauna Hawaiiensis, I, Pt. V, p. 713, 1907.

[6] Meyrick, Bombay J. Nat. Hist. Soc., p. 416-417, 1906.

[7] Meyrick, Handbook of British Lepidoptera, p. 381, 1895.

FAMILY TINEIDAE.

Ercunctis flavistriata Wlsm. (Sugar Cane Bud Moth.)

(Plate II, Figs. 1-6.)

"Antennae yellowish-white, with two small grey spots above before the apex. Palpi yellowish-white, brush-like beneath; the terminal joint very short. Head and thorax yellowish-white. Forewings yellowish-white, indistinctly streaked with broken yellow lines along the fold, along the cell, and below the costa beyond the middle; also sparsely speckled with black scales, especially beyond the middle; a short blackish streak at the upturned apex runs to the end of the apical cilia and is joined by a slender golden brown streak along the base of the shining, white costal cilia; terminal cilia whitish cinereous, with a blackish spot in their middle below the apex. Exp. al. 14 mm. Hindwings shining, pale golden yellowish, becoming white at the apex; cilia pale yellowish-grey. Abdomen and legs yellowish-white." [Walsingham, "Fauna Hawaiiensis," I, Pt. V, p. 716, 1907.]

This moth is variously known as the "bud moth," "budworm," or "sheath moth" of the sugar cane. It is very abundant in all cane fields throughout the Hawaiian Islands. The larvae are always to be found beneath the leaf-sheaths of the older leaves which are partially or completely dead and dried. They are most abundant where no stripping has been done or where there is more or less of a tangled mass of leaves. They normally feed upon the dried leaf-sheaths themselves, also on the leaves. On the sheath they feed on the inner side towards the cane stalk, eating out between the strands of fibers, often burrowing into the substance of the leaf-sheath (Plate I, Fig. 1). Besides their normal feeding, however, they often eat off the surface of the rind for considerable areas, particularly at or just above the nodes where it is apt to be softer; but they sometimes eat off the surface from a whole internode. This eating of the surface is most likely done while the rind is yet growing, before it becomes hardened.

Besides all this, the worst damage is done when they eat out the buds or "eyes," which they sometimes do for several in succession, or for from one to three feet of the cane stalk (Plate I, Fig. 2). The eating of the leaf-sheaths and the leaves does no apparent injury to the cane, as the eating is done on the dead or nearly dead leaves; but the eating of the rind may be considered as injurious in the extent to which it may allow an entrance for fungus spores, etc. The eating of the "eyes" is a serious injury, however, not alone from its producing a condition, or an opportunity for the admission of fungus spores; but chiefly by its rendering the cane valueless for "seed." This would not apply of course where only "top-seed" is used for planting, as usually this is higher than where the "bud worms" are accustomed to feed; but where, as is often the case, short ratoons are used for seed, and the whole of the stick used, the cuttings from the lower part, or even the whole stick, may be quite worthless for planting on account of the number of "eyes" which have been eaten by this insect. The eating is often done in such an obscure way as to be readily overlooked. Usually the larva eats a tiny hole through the outer scales of the bud and consumes the inner soft portion. This entrance hole may be made at the base of the bud, or behind it, where not readily seen; hence, the extent of the injury is not always conspicuous, but thorough examination should be made of any doubtful cuttings where the larvae are noticed in abundance. Their presence is made known (even though not seen themselves), by the silken web by which they partially conceal themselves and endeavor to protect themselves from enemies, and also by the numerous tiny pellets of excrement which are always present where they have been feeding, whether at the base of leaves, or on the outside or inside of the leaf-sheaths.

The larvae of this moth also feed on dead leaves of palms, bananas, pineapples, and *Pandanus*; and amongst the bananas on the bunch eating dead tissues and sometimes the skin of the fruit. They are also often numerous amongst the fibrous material at base of palm leaves; and frequently amongst the bracts at base of pineapples. In none of these places, however, are they to be considered injurious, merely feeding on dead tissues.

LIFE HISTORY.

The eggs (Plate II, Fig. 3) are laid singly, or often a few near together, on the inner surface of the leaf-sheath, sometimes on the outer surface as well, deposited lengthwise in the slight longitudinal grooves of its surface. I have counted as many as twenty-three on one sheath, sixteen of which were within a distance of an inch and a half. When deposited on the inner surface of the leaf-sheaths, of course, it is only on those which have separated at the top to allow the entrance of the moth. An egg is oval-oblong, about 0.75 mm. long and 0.25 mm. wide, upper surface convex, finely reticulated, and with three to seven nearly parallel longitudinal carinae; whitish, or more or less pearly iridescent. The length of time before hatching is about two weeks or more. The length of the larval period is quite long considering the size of the larva. One which I reared became full-grown in eight weeks from time of hatching.

The full-grown larva (Plate II, Figs. 4, 5) is about 12 to 15 mm. It is cylindrical, with the head and the anterior segments about the same width as the rest of the body. It is of a dirty whitish color; head pale reddish-brown and eyes dark. The head is horizontal and somewhat retracted into the segment behind it, which is somewhat infuscated; there are also some fuscous spots on the sides of this, and the next segment. Tubercles fuscous-centered at the base of hairs; tubercle ii about twice as far from dorsal median line as tubercle i; iii just above spiracle; iv posterior to spiracle and lower; v below spiracle and anterior of it. Spiracles circular, pale yellowish, minute.

The pupa (Plate II, Fig. 6) is 5.5 to 6 mm.; very pale yellowish-brown, eyes darker; head with a compressed protuberance in front which is rounded above, but with a sharp angle below, this is darker than rest of pupa; fine hairs situated same as on caterpillar; all of abdominal segments except first and second movable; near basal dorsal margin of segments four to eight is a slight transverse ridge armed with a row of numerous short spines which probably assist in emerging from cocoon; cremaster has two short, stout spines on dorsum, slightly curved forward, and two short conical ones ventrally, wide apart; wing-cases extend to about apex of fifth abdominal segment, free beyond third segment; antenna- and leg-cases extend about two segments farther.

The pupa is formed within a cocoon made in the same location in which the larva has been feeding (Plate I, Figs. 3, 4). It is 6 to 10 mm. long and usually has an outer layer of fibrous material from the leaf-sheath where the larva fed; sometimes it is covered with a layer of pellets of excrement instead, and if the larva has fed on the outside of the leaf-sheath of a variety of cane having numerous bristles on the leaf-sheaths, the cocoons will be covered with these, the latter and the fibers are laid on lengthwise of the cocoon and make it spindle-shaped, one side of cocoon is made onto the surface of leaf-sheath or whatever it is attached to. The moth emerges in about two or three weeks.

The adult moth is about 12 mm. with the wings spread; with them folded at rest on the back the insect is 5 mm. It is not conspicuous when at rest, on account of its pale color and the fact that it rests so close to the object it is on, usually the under side of the cane leaf, and often in the hollow next to the midrib. They may often be seen flying when the cane is disturbed. They are of a yellowish-white color (sometimes greyish-white) with a few yellower streaks and numerous black dots on forewings. There is a black streak at apex of wing which is sharply upturned.

Ereunetis minuscula Wlsm.

(Plate II, Figs. 7-9.)

"Antennae rather stout, enlarged at the base, simple in the male; creamy white. Palpi projecting more than the length of the head beyond it, brush-like beneath; creamy white. Head rough; cream-colored. Thorax cream-colored. Forewings cream-colored; more or less shaded and speckled with umber-brown, this shading being concentrated (and therefore more conspicuous) from the base along the first half of the fold, from beyond the middle of the costa to the lower angle of the cell, and in a subapical oblique costal streak; a dark fuscous streaklet immediately before the extreme apex is preceded by a whitish costal patch; the termen deeply incised below and opposite to it, causing the apex of the wing to turn up sometimes almost at right angles to its surface; cilia creamy whitish, with a slender reduplicated umber-brown line close to their tips. Exp. al. 9 mm. Hindwings, male, with a hyaline patch at the base; pale golden yellowish, sometimes with a cupreous tinge; cilia whitish, with a slight golden or cupreous tinge, a slender reduplicated curved line of umber-brown running through them around the extreme apex. Abdomen whitish-ochreous. Legs creamy white." [Walsingham, "Fauna Hawaiiensis," I, Pt. V, p. 716, 1907.]

This moth is closely related in habits to the preceding, except that I have never yet found its larvae feeding in cane, though I have taken the moth in cane fields. It is more common to find them feeding on the dead leaves of palm, banana, pandanus, etc., and in the dry and decaying pods of various legumes, as tamarind and various Cassias. I have also found them in decaying stems of various woody plants. They are also usually to be found among the dead bracts at the base of pineapples, not injurious to the pineapples, however; in fact, I do not at present know of any injuries caused by them, as they habitually feed on dead plant substances. I once found them quite numerous on lantana bushes which were infested by *Orthezia insignis,* and had numerous larvae also of *Cryptoblabes aliena, Thyrocopa abusa,* and *Batrachedra rileyi* feeding on the dying bushes or the debris caused by one or another insect being present.

The larva (Plate II, Fig. 8) is very similar to that of the preceding species, but paler, of a whitish appearance; tubercles not fuscous and no fuscous markings behind cervical shield. The pupa (Plate II, Fig. 9) differs by having four teeth close together ventrally on cremaster, instead of two, wide apart; there is also a sort of transverse dorsal pit between segments six and seven; and the frontal protuberance on the head is wider and bounded by two carinae which converge dorsally, less sharply pointed ventrally. The cocoon is similar to that of *flavistriata.*

Ereunetis penicillata n. sp.

Very similar to *E. minuscula,* but the male has an elongate, oval, yellowish-brown patch of modified scales in cell of forewing below; and a strong, yellowish-brown costal hair-pencil on hindwing; while the transparent spot near base of cell in hind wing of *minuscula* is lacking.

The pupa is similar to *minuscula* also, except that it has a short conical tooth on each side of cremaster instead of the four ventral ones in *minuscula;* the frontal protuberance more prominent, with the two carinae contiguous.

I bred two males of this species from cocoons in fallen dried Pandanus leaves at Kilauea, Kauai.

Ereunetis simulans (Butl.).

(Plate II, Figs. 10-12.)

"Antennae white, annulate with brownish cinereous, basal joint white. Palpi porrect, with large expanding brush beneath, extending to the tip; white. Head white. Thorax white, with a blackish spot on the anterior margin and another posteriorly; the base of the tegulae blackish. Forewings creamy white, with large clearly defined blackish spots or patches (varying in different specimens); the first near the base of the costa extends obliquely outward and is narrowly connected along the extreme margin with a large quadrangular costal patch, at one-third, reaching to the fold and there connected at its inner angle with a small patch below the fold; near the base is a small triangular dorsal patch opposite the first costal; scarcely beyond the middle is a smaller quadrangular costal patch, followed half way to the apex by an irregularly triangular costal patch with serrate inner margin (its apex sometimes connected narrowly with the terminal shading), between these two, but below them, is a distinctly triangular patch on the lower angle of the cell, its apex reaching nearly to the fold; two smaller dentate dorsal patches tend obliquely outward, the first about the middle, the second about the tornus; a roundish patch at the upturned apex of the wing is partly connected by scattered scales with a less distinct diffused patch on the middle of the termen; cilia white, tinged with fuscous on the middle of the termen, a fuscous line running through their middle. Exp. al. 20-23 mm. Hindwings and cilia rather shining, pale brownish cinereous. Abdomen and legs pale brownish cinereous, the tarsal joints whitish, slightly spotted with brown." [Walsingham, "Fauna Hawaiiensis," I, Pt. V, p. 715, 1907.]

This is larger than the preceding species and quite distinct from them in markings of the adult moth, it being white with black spots. These spots are larger in the females than the males.

The larvae of this species feed in dead wood, particularly the bark and outer parts of stems and trunks. The "hau" tree is a great favorite with them, but many other species are attacked as well. Their presence may be known by the numerous black pellets of excrement, which are to be seen on the outside of the bark and in crevices, where they cling by the web which the caterpillars produce in abundance.

The eggs are white, about .5 mm. long by about as much in diameter, cylindrical, rounded at the ends, a little larger at one end on which is a circle of elongate spines bifid at tip, placed close together; surface slightly corrugated. They are deposited by the female in crevices and beneath loose pieces of bark, quite a number in a batch. In some batches twenty-seven, forty-seven, and fifty respectively were counted. They were quite regularly placed, flattened somewhat by being crowded beneath the bark.

The full-grown larva (Plate II, Fig. 11) is 25-30 mm. long, of a dirty whitish color; the head dark reddish-brown; cervical shield with a wide transverse blackish-brown band; segment three mostly pale brownish, the tubercles of other segments of the same color; spiracles circular, pale brownish.

Pupation takes place in a tough cocoon in a tunnel in which the caterpillar has lived, it being either near the outside, or else has one end near the outside so that the moth may readily emerge. The empty pupa cases may be seen projecting from these after moths have emerged. The pupa (Plate II, Fig. 12) is about 10 mm. long; quite similar to that of *minuscula* except that it is larger and has two conical teeth wide apart ventrally on cremaster instead of four close together as in *muscula;* and the frontal protuberance is more prominent, in lateral view the ventral point is about a right angle, and there is but one carina extending dorsally.

Ereunetis pilosata n. sp.

Male, 9 mm. Antennae whitish-ochreous irregularly marked above with dark fuscous, basal segment dark fuscous, with pecten below. Palpi cinereous-fuscous. Head and thorax cinereous-fuscous. Forewings irregularly mixed with white and fuscous, and a sprinkling of black scales, a few pale brownish scales along dorsum and a spot at apex; cilia cinereous fuscous; apex upturned. Hindwings pale ochreous; cell on upper surface clothed with pale ochreous elongate scales; space between cell and costa clothed with long yellowish hairs; an oval transparent spot at base below lower margin of cell; cilia pale cinereous-ochreous, a few dark fuscous scales at apex. Abdomen fuscous mixed with ochreous, especially on the segmental margins. Legs fuscous, hind tarsi marked with whitish.

Two males, British New Guinea (Muir). The larva feeds in cane similarly to what *E. flavistriata* does in Hawaii.

Ereunetis muiriella n. sp.

Female: 10 mm. Antennae whitish-ochreous faintly marked with fuscous. Palpi ochreous. Head pale grey. Thorax greyish-ochreous with a black spot posteriorly. Abdomen shining greyish-white. Forewings pale ochreous grey; a narrow black line on basal third of costa; a small black spot beneath costa near base; a black dot about the middle of fold; a tiny black dot in cell; four tiny black dots beneath outer half of costa; apical portion of wing with several suffused dark fuscous spots, cilia grey, spotted with dark fuscous around apex. Hind wings and cilia pale shining grey, a few fuscous scales at apex; oval transparent area below cell at base. Legs grey, tarsi fuscous-marked.

One female, British New Guinea (Muir). The larva feeds in cane similarly to what *E. flavistriata* does in Hawaii.

Opogona aurisquamosa (Butl.).

(Plate III, Figs. 1-3.)

"Antennae very pale fawn-ochreous (almost whitish), the basal joint somewhat dilated and flattened, whiter than the stem. Palpi pale fawn-ochreous above, straw-white beneath. Head shining, pale fawn-brown; face shining, steel-white. Thorax shining, varying from brown to deep purplish. Forewings irridescent, dark purple, varying to pale fawn-brownish (but chiefly in worn or greasy specimens), with minute transverse lines of golden scales, more noticeable towards the apex than on the basal half, these coalesce in some specimens forming a costal spot before the apex, and occasionally a dorsal spot near the end of the fold: cilia dull pale brownish ochreous, varying to grey. Exp. al. 12-14 mm. Hindwings shining, bronzy greyish, with bright aeneous sheen around the margins, silvery white on the costa about the base; cilia dull pale brownish ochreous. Abdomen shining, pale fawn-brownish, varying to dark purplish grey. Legs pale ochreous." [Walsingham, "Fauna Hawaiiensis," I, Pt. V, p. 713, 1907.]

The larvae of this moth are often associated with bud-worms, and feeding in a similar manner; hence, they are also responsible for some destruction of the eyes of the cane. They occur more abundantly, however, feeding inside of diseased, dead, or rotten cane, especially in those shoots which have been choked or smothered and have died off at the top, and in cane sticks which have been attacked by borers. In the latter, many may often be found in old borer tunnels, feeding on the chewed-up cane left by the borer, or on the disintegrating substance of the cane itself. They also feed on decaying fruits and other decaying substances, on the dead leaves of bananas and palms, and in rotten wood. I have found them quite numerous in fruit clusters and dead stems of the castor oil plant, and in decaying bamboo stems, also in *Pipturus*, *Clermontia*, and other native trees in the mountains. I once reared quite a number of the moths from dried cow dung. They occur generally throughout the islands and are always found in cane fields, though not particularly injurious on account of their general feeding habits as given above. The species is also known in the Marquesas and the Society Islands.

The moths may often be seen at rest on the cane leaves. They are of a bronzy-yellowish color with metallic reflections. They are about ¼ inch in length with the wings folded over the back.

The wings are somewhat bent down at the tips. The antennae extended forward.

The full-grown larva (Plate III, Fig. 3) is about 15 to 18 mm. long, dull dirty white; finely pubescent, except head and segment two; head and cervical shield blackish-brown; tubercles slightly infuscated, especially those of segments two to four; tubercles i and ii in a straight longitudinal line, iii separated into two above the spiracle, iv and v below spiracle and about as far apart as iiia and iiib above; spiracles pale with black margins. Like *Ereunetis* larvae, they are of slow growth; the length of larval period has not been definitely determined.

The pupa (Plate III, Fig. 2) is 6-6.5 mm. in length; nearly uniform light brown, paler below, darker at extreme anterior end; fine hairs are situated where they were on the caterpillar; head bluntly, triangularly produced in front near ventral side; all of the abdominal segments movable, except first and second; near basal dorsal margin of segments four to eight is a slight transverse ridge armed with a row of numerous short spines, which assist in emerging from the cocoon at the time the moth emerges; cremaster has two short, stout spines on dorsum and slightly curved forward, two slight conical protuberances on ventral side; antenna- wing- and leg-cases extend to near middle of eighth abdominal segment, free beyond third segment.

The pupa is formed in a compact cocoon made in the place where the larva has fed. The cocoon is about 8 mm. long by 2.5 mm. in diameter, rounded at the ends and covered with frass and other debris, few fibers of the cane or leaves, etc.; at each end, a strip of white silk extends out about 5 mm. onto the surface of whatever the cocoon is attached to. About ten days are passed in the pupal stage.

Opogona apicalis n. sp.

(Plate III, Figs. 4 and 5.)

Antennae ochreous-brown, banded above with fuscous, basal segment fuscous-brown above; palpi brownish-ochreous, darker on outer side, a few large bristles on outer side of median segment; head tufted above with ochreous-brown hairs, smooth-scaled in front, ochreous; back of head, thorax, and patagia, dark fuscous-brown; forewings fuscous-brown mixed with a few ochreous scales, an ochreous spot on dorsum near base, another at end of fold, cilia brownish-ochreous; hindwings pale brownish-ochreous, darker at apex, cilia ochreous. Male with a whitish-ochreous hair-pencil on upper side in a fold along vein eight. Fore and median legs ochreous-brown, paler at apex of tibia and tarsal segments; hind legs ochreous, tibiae rough-haired; abdomen ochreous. Forewings up-turned at apex as in *Ercunetis.* 18-20 mm. with wings spread.

This moth is very abundant on the windward side of Hawaii. It is not included in the Fauna Hawaiiensis, which would indicate that it was very rare when Dr. Perkins was collecting and has since become numerous, or else that it is a recent introduction which has now become very numerous. It does not answer to any description in literature available, hence I have described it as new.

The larvae are often numerous in dead cane, especially those which are rotting on account of having been badly bored by the cane borer (*Sphenophorus obscurus*); and shoots which have been killed by "iliau," or have died from being smothered, or any other cause. I have not known of their causing the death of the cane, but their appearance comes after the beginning of decomposition. They may sometimes eat the lower eyes of cane where there is a lot of wet trash at base of cane. They prefer wet situations, and for this reason they have not been observed in the sugar plantations of Oahu. They occur on this island, however, as I have collected the moths at Wahiawa, and found the larvae in rotten logs. On Hawaii, I have found the larvae in the stipes of dead fronds of tree ferns; and the moths came numerously to lights, when I staid over night once at Waimea.

The full-grown larva (Plate III, Fig. 5) is about 20 mm. long; of a dirty whitish color; head and cervical shield blackish-brown, large blackish-brown chitinized plates enclosing tubercles of segments 3 and 4; tubercles of other segments fuscous with black center at base of hair except those of iiib series; tubercle ii directly behind i so that they form two straight longitudinal lines down the back; iiia and iiib wide apart, iiib just over spiracle, iiia farther forward; iv just behind spiracle and, contінguous to it; v below iiia; hairs dark brown; spiracles black; surface of body covered with minute black pubescence.

The cocoon is like *O. aurisquamosa.* The pupa is quite similar, but a little larger and does not have the two conical projections ventrally on the cremaster.

Opogona saccharella n. sp.

Head metallic fuscous above, pale fawn below. Palpi pale fawn, fuscous externally. Antennae pale fawn, basal segment fuscous above. Thorax dark bronzy fuscous, sulphur-yellow posteriorly. Abdomen and legs pale metallic fawn. Forewings very long-pointed, sulphur-yellow; a dark fuscous streak along basal sixth of costa; a very oblique black postmedian line from about ¾ of costa to a little before end of fold, area beyond this metallic fawn with a few violet scales; cilia pale fawn. Hindwings and cilia pale metallic fawn. 12 mm.

Near *O.* (*Lozostoma*) *protodoxa* Meyr., which is common in Australia.

One specimen, British New Guinea (Muir). The larva feeds in sugar cane similarly to what *O. aurisquamosa* does in Hawaii.

Opogona fumiceps Felder.

Felder, Reis. Nov. Pl. CXXXIX, Fig. 8.

Meyrick, Journal Bombay, Nat. Hist. Soc., XVII, p. 986, 1907.

"Male and female, 12-18 mm. Head dark fuscous, face bronzy-white. Palpi whitish. Antennae ochreous-whitish, basal and next two or three joints dark fuscous. Thorax yellow, anterior third dark fuscous. Abdomen pale grey or greyish-ochreous. Forewings elongate-lanceolate; bright yellow; a thick dark fuscous streak along basal fifth of costa; apical half beyond an irregular line from middle of costa to beyond middle of dorsum rather dark fuscous except a triangular yellow spot on costa towards apex; small suffused dark fuscous spots beneath costa and on dorsum immediately beyond dividing line; cilia dark fuscous. Hindwings fuscous; cilia pale fuscous." [Meyrick, l. c. above.]

One female, British New Guinea (Muir). The larva feeds in sugar cane similarly to what *O. aurisquamosa* does in Hawaii.

It agrees very well with Meyrick's description, but not with Felder's figure; in fact, this figure and Meyrick's description do not exactly agree either. I have no doubt but that my specimen is *fumiceps*. It occurs in Java and Ceylon, which are some distance apart, and as it is reported as feeding on coconut palms in Java,* it might have considerable range in the Malayan and Pacific islands. As *Opogona aurisquamosa* in Hawaii feeds on palms and other plants besides sugar cane, it might not be unexpected if *fumiceps* was found to feed on both palms and sugar cane.

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* Van Deventer, Tijd. Ent., XLVII, p. 83, Pl. X, Figs. 1a, 1b, 1904.

The Dancing Moth.

(Plate III, Figs. 6-8.)

This is probably a somewhat recently introduced moth and at present remains undertermined. Dr. Perkins collected it in Honolulu in 1901, but it is not included in the "MICROLEPIDOPTERA" of the "Fauna Hawaiiensis." I believe that Walsingham has had specimens for identification recently, but I have not heard the results. I am unable to place it generically from the literature available.

It is already abundant on Oahu, but I do not know whether it occurs on the other islands or not. Its larvae are often found in sugar cane associated with larvae of the bud moth, and I have sometimes found them quite numerous though never enough so to do any noticeable injury. They are also to be found on pineapples amongst dead leaves, and the dead bracts at the base of the fruit; and among dead or dying leaves of banana and *Pandanus*. The moth is often seen amongst ferns in the mountains.

The moth is smaller than those previously mentioned. With wings folded at rest it is but 4 mm. long (less than ¼ inch) and the breadth with wings spread is about 8 mm. or 5/6 inch. It is white to yellowish-white and the fore wings have more or less brownish markings, sometimes nearly all pale brown with blackish markings; hind wings paler; head and antennae white, the latter banded with black. It has the peculiar habit when first alighting upon a leaf or anything, of running around with much gyrating; hence the name.

The full-grown larva (Plate III, Fig. 8) is about 9-10 mm., cylindrical, head and following segment slightly narrower than rest of body; very dark brown, also two brownish spots on each side of segments three and four; rest of body somewhat fuscous but usually appearing blackish on account of the contents of the alimentary canal; tubercles quite conspicuously prominent, slightly darkened, hairs long, dark, those of tubercles i and ii curved forward; tubercles i and ii in a straight longitudinal line; tubercule iii just above spiracles; iv and v separate, below spiracle, v anteriorly and somewhat lower than iv.

The larva does not spin much silk for its protection, and does not make a cocoon for pupation. The pupa (Plate III, Fig. 7) is formed in an irregular network of silk, made on the inner side of the leaf-sheath where the larva has lived. It is 3.5 mm. long by a little over 1 mm. wide (about 1/8 by 1/16 inch); medium brown, pale on ventral side; slightly flattened and widest in middle portion; wing- and antenna-cases extend to apex of sixth abdominal segment, which is nearly to extremity of body, for the first four abdominal segments are large, and the remainder are very small; spiracles raised on slender projections which widen out broadly at base; hairs conspicuous, those on the back hooked at the tip and fastened into the network of silk above it; apex of abdomen blunt, rounded, with numerous scattered straight hairs; head with two blunt protuberances between the eyes. The pupal period lasts seven to nine days. Other details of life history not yet known.

FAMILY GELECHIADAE.

Autosticha pelodes (Meyr.).

(Plate IV, Figs. 1-3.)

"Head, palpi, antennae, thorax, abdomen, and legs, whitish-ochreous, thinly sprinkled with fuscous; second joint of palpi externally densely irrorated with dark fuscous, terminal joint with a slender blackish median ring. Forewings moderately elongate, costa moderately arched, apex obtuse, hind margin obliquely rounded; whitish ochreous, somewhat suffused with ochreous, and thinly sprinkled with dark fuscous; a blackish dot at base of costa; a small blackish dot in disc before middle, a second rather obliquely beyond it on fold, and a third more conspicuous in disc beyond middle; a row of blackish dots between veins on hind margin and apical fourth of costa; cilia whitish-ochreous sprinkled with fuscous. Exp. al. 15 mm. Hindwings whitish-ochreous slightly greyish tinged; cilia whitish-ochreous." (Meyrick) [Walsingham, "Fauna Hawaiiensis," I, Pt. V, p. 487, 1907.]

This is another moth whose larva is sometimes associated with bud worms in the cane. They are much less numerous, however, and distinctly larger, and probably do no injury. I have also found the larvae in dead sticks of castor oil plant and lantana; in fibrous matter at base of palm leaves; and on dead or partially dead twigs of Araucarian pine.

The larva (Plate IV, Fig. 3) of this species is large and distinctly different from the bud worm. When full-grown it is about 20 mm. in length; cylindrical, head and two following segments narrower than rest of body; head bright reddish-brown, eyes black; cervical shield blackish-brown; segments three to six, blackish, becoming paler posteriorly; remaining segments more or less fuscous with somewhat of a purplish tinge; tubercles i, ii, and iii, large, circular, slightly convex, a dark dot at base of hairs; other tubercles smaller; hairs long, reddish; spiracles dark with pale centers, those on segments three to eleven, minute.

The pupa (Plate IV, Fig. 2) is formed in a slight cocoon of white silk where the larva has lived. It is about 7 mm. long; uniform, medium brown; antenna- and wing-cases extending to near the apex of fourth abdominal segment; on dorsum of fifth abdominal segment is a band near the base, having longitudinal striations; cremaster flattened dorsiventrally, abruptly contracted to a median spine which has a double hook at the tip fastened into the silk of the cocoon. The pupal period is thirteen to fifteen days. Other details of its life history are not known.

FAMILY ELACHISTIDAE.

Batrachedra rileyi Walsm.

(Plate III, Figs. 9, 11.)

"Head chestnut-brown; palpi widely divergent, whitish, with an oblique pale brown mark on each side near the end of the second joint, and two or three brownish spots on the sides of the apical joint. Antennae with white and fuscous annulations; the basal joint elongate, chestnut-brown. Forewings chestnut-brown, slightly shaded with fuscous towards the costal margin; a whitish-ochreous streak at the base of the dorsal margin, followed by two or three other smaller ones along the dorsal margin (in some specimens these are obsolete); above the dorsal margin are two oblique whitish-ochreous streaks, the first before the middle, the second before the anal angle. A similar streak from the costal margin immediately before the apex is outwardly margined by a streak of black scales, the apex and apical margin being also black; there is also a faint fuscous streak running downwards through the cilia below the apex. On the cell are two elongate patches of black scales, one immediately before the middle of the wing, the other halfway between this and the base. Fringes grey, with a slight yellowish tinge. Hind wings pale greyish. Hind tibiae greyish-white, outwardly fuscous; hind tarsi whitish, with a wide fuscous band followed by two fuscous spots on their outer sides. Expanse 11 mm." [Walsingham, Tr. Am. Ent. Soc., X, p. 198, 1882.]

The larvae of this tiny little moth, I have found feeding in various situations, most frequently on dead vegetable matter or refuse substances, hence, not particularly injurious. I have found them feeding beneath leaf-sheaths of dead cane, also in borered cane sticks, and in places where the leaves are dirty and sticky from having been attacked by Aphis or leaf-hoppers. I have also found them feeding in the tassels. Once I found them very numerous in sweet corn ears feeding on the "silks," inner husks, the pith, and other parts of the cob. I have also seen them in ears of field corn, eating into the kernels of corn and into the cob. Another time I observed them numerously on a large woody twining bean vine, feeding on dying leaves and ripening pods, especially where there was an accumulation of debris, webs, frass, etc., on account of infestation by mealy bugs, *Lecanium*, *Tortrix,* and *Cryptoblabes* larvae. Similarly, I have found them feeding on lantana infested by *Orthezia,* and on palm leaves infested with mealy bugs and leaf-rollers; also on dead leaves of pandanus, banana, and various other plants. On the banana, I have found them feeding in the bunch on the dead or injured fruit, and on the skin of the ripened fruit, which they have penetrated sometimes and eaten into the fruit inside.

Mr. D. T. Fullaway has reported it from cotton infested with mealy bugs. The original description of the species is from specimens bred from rotten cotton-bolls in the United States. It has been present in these Islands for a number of years no doubt, as they were found by Dr. Perkins when he first came (1892), though it is not included in the Fauna Hawaiiensis.

The other species of this genus show a variety of habits so far as these are known. Some breed in heads of Juncus[8] and sedges, catkins, and seeds of poplar and willow,[9] in plant galls[9] (though not producing them), pine needles,[10] others in webs of other larvae and of spiders;[9] and one Australian species feeds on the San Jose scale and other scale insects.[11] A Hawaiian species feeds on ferns.

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[8] Meyrick, P. L. S., N. S. W., XXII, p. 301, 303, 305, 1898.

[9] Walsingham, Tr. Am. Ent. Soc., IX, p. 199, 1882.

[10] Meyrick, Handbook of British Lepidoptera, p. 662, 1895.

[11] Froggatt, Australian Insects, p. 280.

LIFE HISTORY.

Eggs are deposited mostly singly, occasionally two together; about .5 mm. long, roundish-ovate, flattened below where in contact with surface of object, convex above and coarsely reticulate. They hatch in a few days. The freshly hatched larvae are about 1 mm. long, pinkish with black head and cervical shield.

The full-grown larva (Plate III, Fig. 11) is about 7-8 mm., pinkish except head which is pale brown, and cervical shield which is dark brown; tubercles concolorous, ii wider apart than i, iii above spiracle, iv + v below.

The larva pupates in a whitish cocoon amongst the frass where it has fed. The pupa (Plate III, Fig. 10) is 4-5 mm. uniform, medium brown; wing-cases and antenna-cases extend to apex of sixth abdominal segment; abdominal segments apparently immovable; terminal segment with numerous slender hooked bristles, a few also on the two preceding segments. The pupal period is eleven to thirteen days.

FAMILY PHYCITIDAE.

Cryptoblabes aliena n. sp.

(Plate IV, Figs. 4-7.)

This moth with wings spread is 14-16 mm. long; grey, thickly irrorated with fuscous. Palpi grey, pale fuscous on outer side of second and third segments. Antennae pale grey. Head, thorax, and fore and mid femora with more or less crimson tinge. Abdomen pale grey brown. Forewings grey, thickly irrorated with fuscous, more or less suffusion of crimson at base, on basal half of costa, and on inner margin, also beyond the cell where it is sometimes confined to the veins; lines obsolete; sometimes a dark fuscous discal dot, and one or two dark fuscous discocellular dots; cilia grey-fuscous, darker at base. Hindwings pale and subhyaline, darker on veins, apex and hind margin; cilia whitish-grey.

The larvae of this Phycitid moth were first noticed in 1905; on sorghum, cotton, and sugar cane. In each case, the plants were considerably attacked by Aphis. On sugar cane they often hide within a retreat made by the margin of the leaf being rolled down and fastened beneath with silk. Often several larvae may be in the same place. They eat off the substance of the leaf, leaving the opposite epidermis, which makes the leaf look dead on the margin. They often feed near the base of the leaf, adjacent to the sheath.

The larvae feed on leaves of sorghum in the same way. They also feed in the tops eating the flowers, bracts, and young seeds.

In 1906, larvae were found very abundantly feeding on sweet corn, which was badly attacked by corn-hoppers (*Peregrinus maidis*). They were beneath leaf-sheaths and husks, and in the ears eating the silks, young grains and even the bracts or chaff of the cob; they were also in the tassels. They spin slight silken tunnels wherever they feed.

More recently, I have found the larvae quite abundant among the flower clusters of Algaroba, both fresh clusters, and the withered and dried up ones. I have also found them on orange, mulberry, and some other plants, feeding where there has been infestation by Aphis or mealy bugs; and in the dried capsules of the castor oil plant.

In May, 1908, I found them abundant on lantana where it was being killed by being attacked by *Orthezia,* the "Maui blight"; and in the same year found them on coffee trees amongst the berries, an occasional one being eaten by them. In all cases where these larvae occur along with Aphis, mealy bugs, etc., they do not feed on these latter insects themselves, although they may be attracted by the more or less sweetish excretions of these insects; they feed, however, largely on the tissues of the plants themselves, either the fresh tissues or else the dead or dying tissues.

It is thus seen that the larvae of this moth are quite general feeders. They are not to be considered very injurious, however; the other insects with which they are usually associated being far more injurious. They have not as yet become injurious to sugar cane; but are generally distributed, as I have occasionally observed the larvae in cane fields of various districts of the Islands.

Larva (Plate IV, Fig. 7) is about 12 mm. long; nearly cylindrical, narrowing towards each end; olivaceous, yellowish, reddish, or fuscous, with several longitudinal darker stripes, brownish or fuscous; most conspicuous is a broad, somewhat double brownish or fuscous, stripe just above line of tubercles iii; head yellowish-brown to dark fuscous, eyes black; cervical shield concolorous, darker on anterior margin; tubercles small, concolorous or pale, with a black dot in center at base of hair; tubercle iii on segments three and twelve surrounded by a darker ring; tubercles i and ii in straight longitudinal line; iii just above spiracle, iv + v below spiracle and a little more anteriorly; hairs very pale brown; spiracles pale yellow. Larvae taken from sweet corn and algaroba blossoms were paler, usually yellowish or reddish; those from lantana, orange and other trees where *Orthezia,* Aphis, mealy bugs, etc., had been feeding, were mostly very dark fuscous, often almost black, and nearly uniformly colored.

Pupa (Plate IV, Fig. 6) is 5-6 mm. long; bright light brown, paler below, greenish on wing- and leg-cases; punctured all over the back; fine hairs in two dorsal, two lateral, and two ventral rows; spiracles slightly raised; wing- and leg-cases extend to near apex of fourth abdominal segment; cremaster with two stout straight spines close together, touching, hooked at tip, firmly fastened into silk of cocoon, a few short hooked spines near their base. Formed in a slight cocoon amongst the web where the larva fed.

I have bred no parasites from the larvae; nor have I ever found any of them stored up for food in wasps' nests. Specimens of the moth were sent to Dr. Dyar, Washington, D. C., for determination. He informed me that they did not agree with any described species; hence, I have described it as new.

NATURAL ENEMIES.

PARASITES.

I have bred two parasites attacking the caterpillars of the bud moth, to some extent, in the cane of the Experiment Station grounds.

FAMILY BETHYLIDAE.

Sierola molokaiensis Ashm.

(Plate II, Fig. 13.)

"Female. Length 2 to 3.5 mm. Black, the head and thorax finely coriaceous but more or less shining; mandibles black or brown-black; abdomen smooth, impunctate, highly polished; antennae, except the four or five terminal joints, and the legs, except the front coxae and more or less of the front femora or at least above, testaceous or brownish-yellow; front coxae and front femora black or dark brown in part, the latter sometimes brownish only above or outwardly; wings hyaline, the parastigma and the stigma brown or fuscous, the other veins pallid or pale yellowish.

"The head is distinctly longer than wide, with an acute ridge anteriorly between the insertion of the antennae, and clothed with a short, sparse pubescence. The antennae are much longer than the head, all the joints of the flagellum being distinctly longer than thick or from 1½ to 2 times as long as thick.

"Male. Length about 2 mm. Black; two or three basal joints of the antennae and the legs, flavo-testaceous, the rest of the antennae being dark fuscous or black. The anterior femora above or outwardly and sometimes the front coxae, more or less, are brown or fuscous. The joints of the antennae 5 to 6 are oval and very little longer than thick, joints 11 and 12 being moniliform, while the abdomen is oblong-oval, not longer than the thorax." [Ashmead, Fauna Hawaiiensis, I, Pt. III, p. 290. 1901.]

Of a lot of cocoons of the bud worm collected in March, 1908, 33⅓% were infested with this little Bethylid. Some contained the *Sierola* larvae feeding upon the bud worm; and one contained adult Sierolas which were all ready to emerge. The number per cocoon varied from two to eight. The larvae feed externally on the bud worm. Probably the adult *Sierola* stings the caterpillar after it has made its cocoon, paralyzes it and lays eggs in or upon it. The larvae get their growth in a few days (as with other parasites which feed upon paralyzed caterpillars). They are plump footless maggots, somewhat curved, nearly transparent, with numerous white dots in their body-wall. When full-grown they are about 3 mm. long. They then spin loose brownish cocoons occupying all the space inside the cocoon of the bud worm. The pupa stage is passed through in about a week.

The parasite breeds more rapidly than the bud worm. It should eventually be a valuable parasite on the bud worm. I first bred one from cane bud worm in May, 1906, and at the time there was some doubt as to whether it was really from the bud worm or not. I have made no observations on it again till recently, though I have occasionally taken a specimen in cane, and have occasionally found bud worms parasitized by it.

FAMILY EULOPHIDAE.

Melittobia hawaiiensis Perkins.

(Plate IV, Figs. 8-10.)

"Black, or brownish-black, the thorax with a faint aeneous reflection, the head and thorax also faintly metallic. The mandibles are reddish and the scape of the antennae is more or less pale, sometimes clear yellow, at other times only more or less obscurely brown in dried specimens. The tibiae and tarsi are yellow, the femora dark, or at least more or less sordid. In fresh specimens the ocelli are enclosed in a pale ring, and the eyes pale-margined, while there is a pale median line on the face, furcate above and below, forming an elongate X-like mark. The mesothoracic sutures are mostly pale, as also the parapsidal furrows and the scutellar grooves. In dry specimens generally all these pale markings disappear. Head convex in front in fresh examples, but collapsing altogether in dry ones; the antennae with elongate scape, widening to the apex, and about as long as the pedicel and funicle joints together, the pedicel obconical and longer than the first funicle joint, the latter not differing much from the two following, and transverse on their widest faces, the club ovate, twice as long as its greatest width, about equal to the three funicle joints together, and with a spine at the apex. Thorax with very short hairs and very minutely punctured, the propodeum smooth and shining and with a median groove. Abdomen usually subparallel-sided in dry specimens and elongate, being about as long as the head and thorax together or rather more. Length rather more than 1 mm. Wings evenly dotted with short hairs and with short marginal fringe; the marginal vein with two rows of long and some shorter setae.

"Male quite unlike the female, blind and with very different antennae, which are 9, not 8-jointed. Color, yellow or brown, sometimes more or less darker in parts, the apical joints of the antennae more or less black. Scape very large, subtriangular, and about as long as all the other antennal joints together; it is concave beneath and some of the following joints are usually withdrawn into the concavity, which is partly closed by the incurved sides, pedicel laminate and often entirely hidden beneath the scape, first funicle joint triangular, very narrow at the base, second and third not differing much from one another, both being wide, fourth very short and transverse, club three-jointed, the funicle joints are set with longish setae. Wings rudimentary, the front pair about as long as the thorax, the marginal vein very long, reaching nearly from base to apex and clothed with many long bristles." [Perkins, Proceedings Hawaiian Entomological Society, I, Pt. 4, p. 124, 1907.]

This little Chalcid was discovered by Mr. Giffard in 1907, bred from larva of some wasp or bee in its nest in decayed branch of tree.* In the latter part of the same year, I found several nests of the leaf-cutter bee (*Megachile palmarum*) in which most of the cells had been parasitized by this Chalcid. I have also reared them in the laboratory upon larvae of three different wasps: *Odynerous nigripennis, Pison hospes,* and *Sceliphron caementarium.* In March, 1908, I first discovered them breeding on the larvae of the bud worm (*Ereunetis flavistriata* Wlsm.) in sugar cane at the Experiment Station. Of a lot of fifty cocoons of the bud worm, collected at one time, six, or twelve per cent., contained a bud worm parasitized by *Melittobia.* Five of them had eggs of *Melittobia* (seven, nine, eleven, twenty, and thirty respectively per bud worm) scattered on the surface, which were allowed to hatch, and reared to maturity. The sixth cocoon contained thirty-five pupae of *Melittobia* which had consumed a bud worm within its cocoon, and were lying in contact with its dried up remains.

Apparently the female *Melittobia* enters the bud worm's cocoon before it is entirely completed, stings the worm and deposits eggs upon her. Or it may be that after entering the cocoon, she waits till the bud worm is assuming the inactive condition previous to the transformation to pupa, and then deposits her eggs upon her; either stinging the bud worm to prevent further transformation, or else the young larvae hatch and begin eating so quickly that further transformation is prevented.

The egg is white, cylindrical, slightly curved, ends rounded, 0.3 mm. long by 0.12 mm. wide. They are laid indiscriminately on the surface of host, singly or several together.

They hatch very quickly and the young larvae feed externally upon the bud worm, becoming full-grown in about a week. They are footless grubs just a little more than 1 mm. in length, and transform to pupae in two or three days. They rest in the pupa stage about two weeks. So many of this parasite develop upon one host, that it should be a very valuable parasite upon the bud worm. I have not as yet ascertained whether it is generally distributed throughout the islands or not. The known hosts of this parasite now include *Megachile, Sceliphron, Pison, Odynerus,* of Hymenoptera, and *Ereunetis* of Lepidoptera.

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* Proc. Haw. Ent. Soc., I, Part 4, p. 121. 1907.

Recent observations show that this parasite confines its attacks mostly to the hymenopterous hosts, especially *Sceliphron* (the mud-dauber wasp so abundant everywhere), and bud worms are not much attacked by them. When breeding on the larva of *Sceliphron,* several hundred larvae of this parasite attain their growth on one larva of the host; I once counted 338 (331 females and 7 males) parasites bred from one larva of *Megachile palmarum.* The preponderance of females is always apparent. In a lot of adults reared from several larvae of *Sceliphron* were 1492 females and 48 males: about 1 male to 31 females. Whether this species is partially parthenogenetic I have not as yet proved.

FAMILY BRACONIDAE.

Microdus hawaiicola Ashm.

"Female. Length 3 to 4 mm.; ovipositor fully as long as the body. Polished black, with the metathorax rugoso-punctate, the first segment of the abdomen being longitudinally striate, the second with a few striae only, a little beyond its middle; the first two joints of the antennae, the clypeus, the cheek, the mandibles, the legs, except as noted below, and ventral abdominal segments 1 to 4, honey-yellow, or brownish-yellow; the palpi, tegulae, trochanters, more or less, and a narrow annulus at base of tibiae, yellowish-white; the hind coxae, except at apex, are black; the middle femora and hind tibiae and tarsi are brown or fuscous, while the hind femora vary from dark fuscous to black. Wings subhyaline; the stigma and the veins, except toward the base of the wings, are brown, the areolet being small, triangular and longly petiolate, the second discoidal cell being open at apex.

"The abdomen is black; the ventral segments 1 to 4 pale, the third and beyond, usually with dusky spots, while the extreme lateral margins of the second segment are yellowish-white." [Ashmead, Fauna Hawaiiensis, I, Pt. III, p. 361, 1901.]

This small black Braconid occurs on the four main islands of the group. I have collected it in cane fields, and once bred a specimen from a bud worm (*Ereunetis flavistriata*) which was amongst bananas on the bunch. It no doubt parasitizes this species to some slight extent. I have also reared it from *Batrachedra rileyi* on a few occasions; and from a Gelechiid (*Stoeberhinus testaceous*) which is very common, the larva feeding amongst dead leaves at base of Bermuda grass and probably other grasses. Dr. Perkins informs me that he has bred this Bracon from many Tineids, especially *Ereunetis simulans.*

The larva of this parasite emerges from the host caterpillar after the latter has spun its cocoon and is about ready to pupate; then finishes eating the caterpillar and makes its own white silken cocoon inside the cocoon of its host. The adult parasite emerges in about two weeks.

I once reared several of these parasites from larvae of *Batrachedra rileyi* found stored in the nest of a wasp (*Odynerus montanus*). The wasp had collected parasitized larvae and stored them up without injuring the parasitic larva inside while stinging to paralyze the *Batrachedra* larva. These parasite larvae then emerged from the latter, after I had examined the wasp's nest; spun their cocoons and developed to maturity.

ANTS.

Pheidole megacephala Fab.

This species of ant is the common medium sized red ant. It is always abundant in cane, often having its nests beneath the leaf-sheaths. It destroys more or less of the young bud worms, also larvae of the other moths which are treated of here.

WASPS.

Odynerus Species.

There are over one hundred species of native wasps of this genus. They all prey upon the larvae of Lepidoptera, storing them in their nests for the young wasps to feed on. Several species have been observed in cane fields hunting for bud worms and other Tineid larvae. On Kauai, *O. blackburni;* on Oahu, *O. montanus* and *O. dubiosus;* on Maui, *O. sandwichensis, O. insulicola,* and *O. konanus.* They are small wasps, mostly black in color, but some have red markings and others yellow.

The nests of these wasps are mostly in cavities of lava rocks; hence, the reason they are so often seen around walls and heaps of stones. Enough caterpillars are placed in a cavity (after having been stung and paralyzed by the wasp) to provide food for one wasp larva; an egg is suspended from one side by a slender filament; then the opening is sealed with mud. The young larva soon eats the caterpillars, then spins a cocoon in which transformation to the adult stage takes place.

GENERAL REMARKS.

The bud worm is not usually considered a serious enough pest to demand any special attention; in fact, its work on the cane is not generally known or understood. The patches eaten by them from the rind have often been ascribed to cockroaches; and the eating of "eyes," to various other insects. Also their work on the inner side of the leaf-sheath is similar to the way the adult cane borer eats in the same place, and the work of one is likely to be mistaken for that of the other. On the other hand, on account of the presence of one or more of the various lepidopterous larvae, treated of in this paper, in dead or diseased cane, they have often been held responsible for the injury.

In this paper, an attempt has been made to point out the true habits of these insects, so that when found in cane, it can be readily ascertained whether harmful or not. By comparing any larvae found, with the illustrations, the species may be determined, then by referring to the text the known habits may be ascertained, and one will know whether to expect injury from them or not. All of the smaller lepidoptera which are known at present to feed on cane, dead or diseased, are included. As has been pointed out, the majority of them are not injurious. For those that do really eat out the "eyes" of cane to some extent, there appears to be no practical remedy, nor is the injury by them sufficient to warrant any extensive operations against them. Clean and thorough stripping, however, makes conditions less favorable for them, for the accumulation of dead leaves and trash usually present in a cane field, is just the sort of condition most acceptable to them. No doubt it would be found in fields of young ratoons intended to be cut purposely for "seed" that to keep well stripped would result in less damage being done, i. e., fewer "eyes" being eaten out; for the eating of the "eyes" is done before the leaf is removed from the cane, while the bud worm has it to hide behind.

Careful inspection of "seed" from such places should be made to avoid the planting of cuttings having one or more "eyes" destroyed.

EXPLANATION OF PLATES.

PLATE I.

Figure 1.—View of the inside of a sugar cane leaf-sheath, the darkened streaks showing where bud worms have eaten away the substance between fibers. Some cocoons and caterpillars also shown.

Figure 2.—A portion of cane stick showing the buds destroyed; and the darkened areas the characteristic manner in which the bud worm eats off the surface of the rind.

Figure 3.—Cocoon of bud worm covered with fibers from cane leaf.

Figure 4.—Cocoon of bud worm covered with frass, empty pupa case protruding.

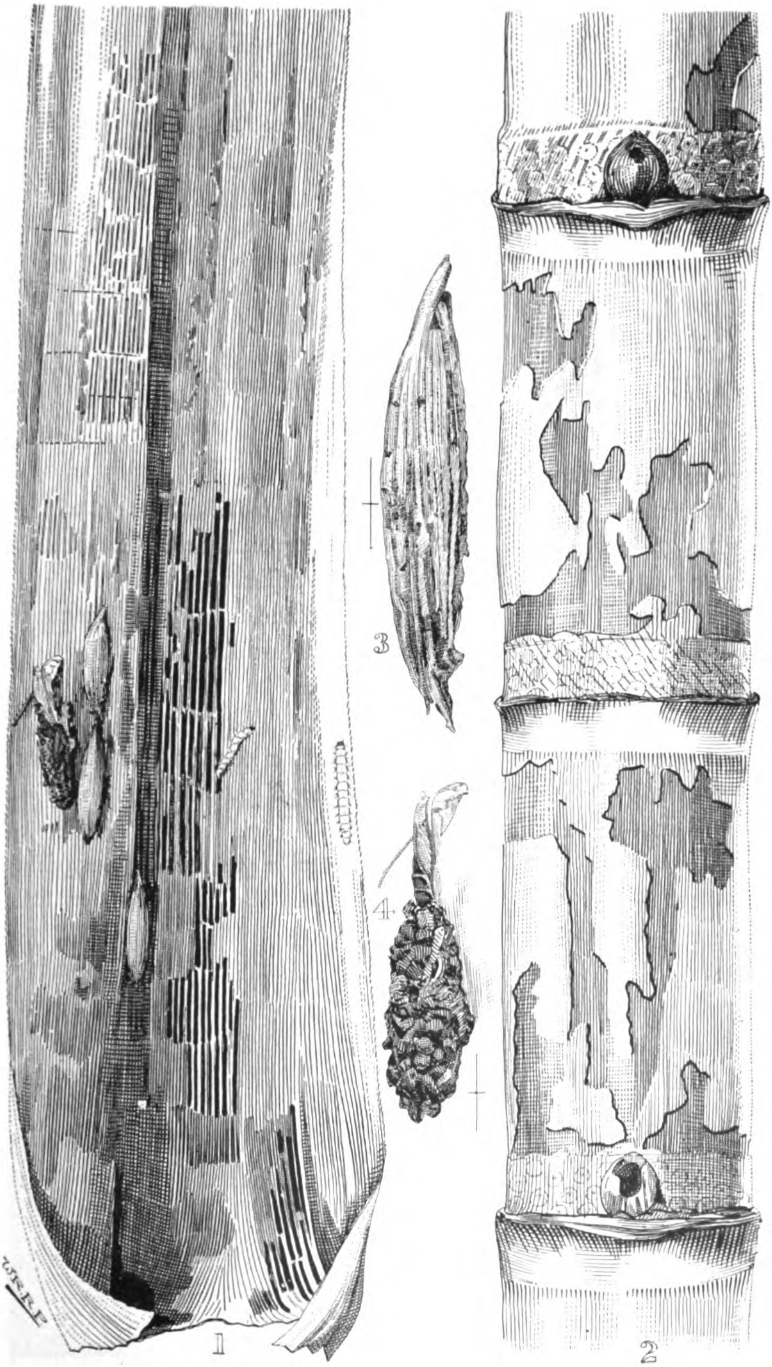


PLATE I.

PLATE II.

Figure 1.—*Ereunetis flavistriata.*
Figure 2.— " showing position at rest.
Figure 3.— " egg on surface of leaf-sheath.
Figure 4.— " caterpillar.
Figure 5.— " head and anterior segments of caterpillar.
Figure 6.— " pupa.
Figure 7.—*Ereunetis minuscula.*
Figure 8.— " anterior portion of caterpillar.
Figure 9.— " apex of pupa.
Figure 10.—*Ereunetis simulans.*
Figure 11.— " anterior portion of caterpillar.
Figure 12.— " pupa.
Figure 13.—*Sierola molokaiensis.*

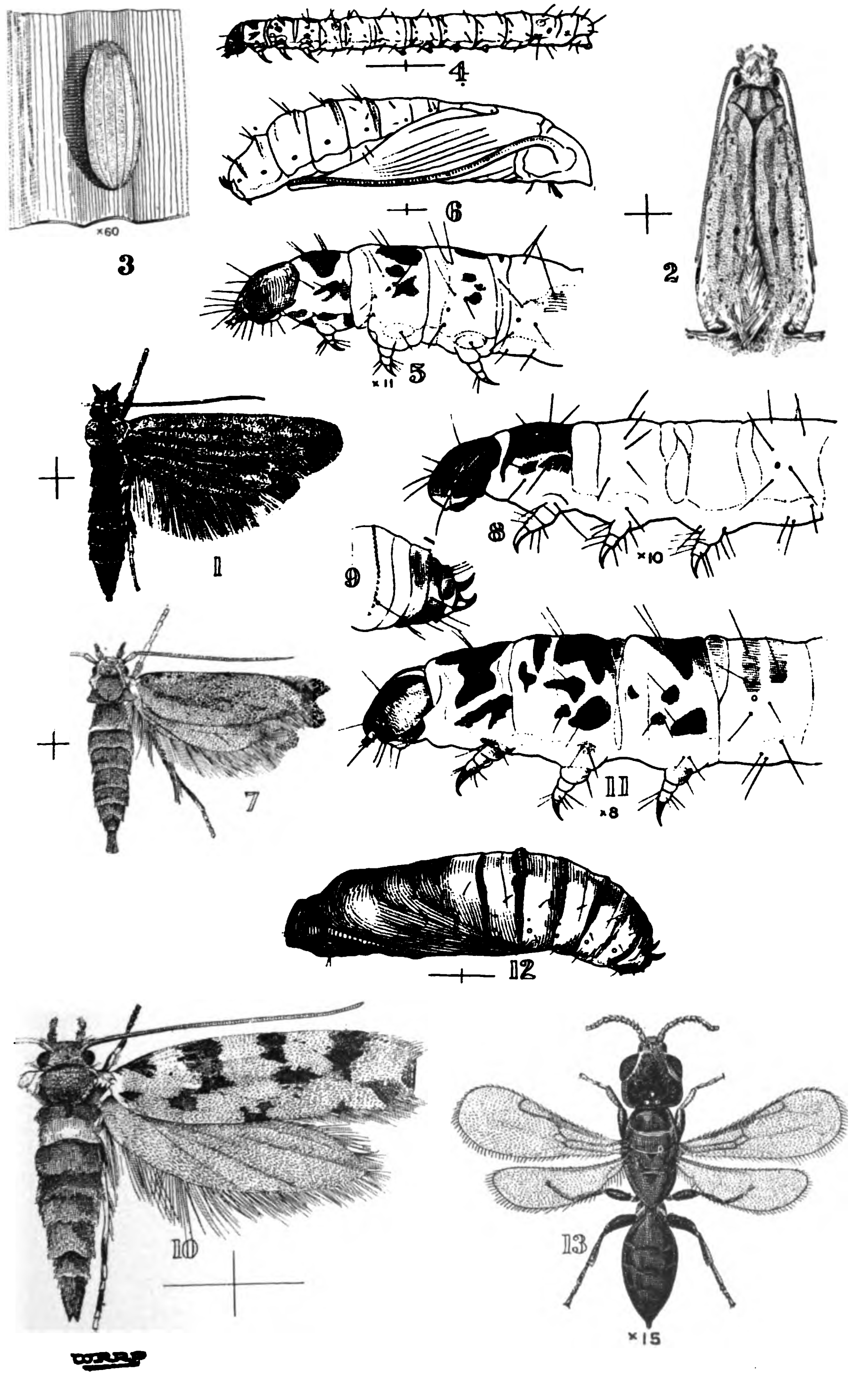


PLATE II.

PART III.

Figure 1.—*Opogona aurisquamosa.*
Figure 2.— " pupa.
Figure 3.— " anterior portion of caterpillar.
Figure 4.—*Opogona apicalis.*
Figure 5.— " anterior portion of caterpillar.
Figure 6.—Dancing Moth.
Figure 7.— " pupa.
Figure 8.— " anterior portion of caterpillar.
Figure 9.—*Batrachedra rileyi.*
Figure 10.— " pupa.
Figure 11.— " anterior portion of caterpillar.

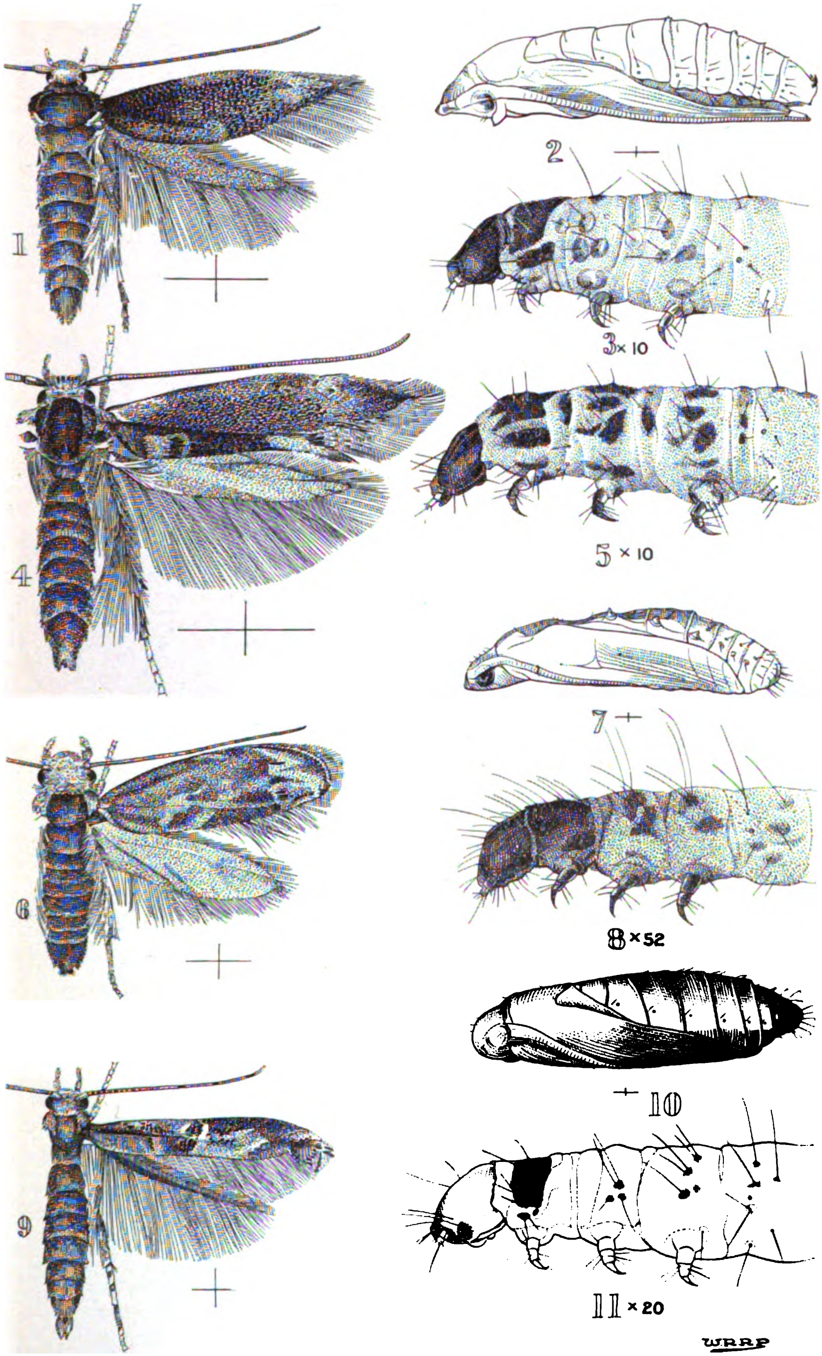
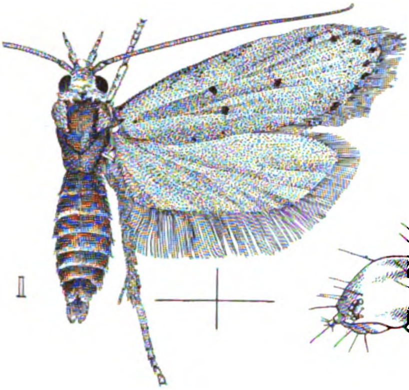


PLATE III.

PLATE IV.

Figure 1.—*Autosticha pelodes.*
Figure 2.— " apical segments of pupa.
Figure 3.— " anterior portion of caterpillar.
Figure 4.—*Cryptoblabes aliena.*
Figure 5.— " showing antennal hook of male.
Figure 6.— " pupa.
Figure 7.— " anterior portion of caterpillar.
Figure 8.—*Melittobia hawaiiensis,* female
Figure 9.— " male.
Figure 10.— " ventral view of male antenna.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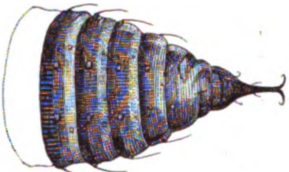
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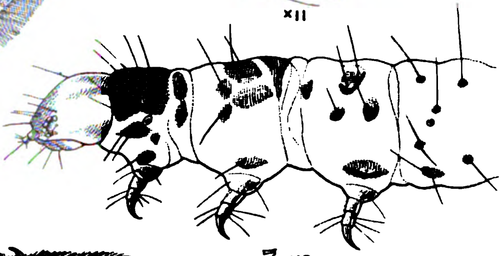
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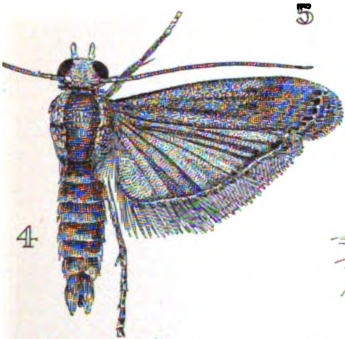
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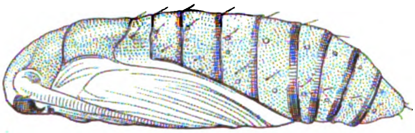
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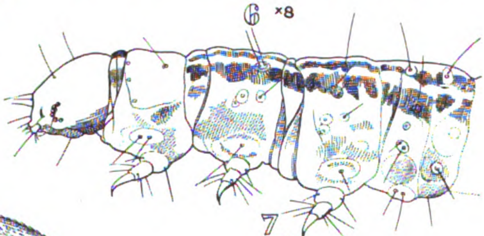
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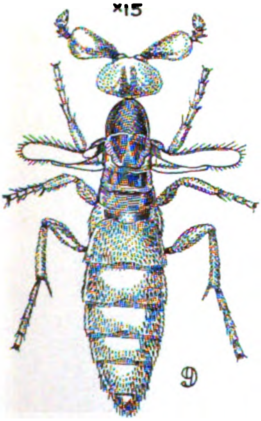
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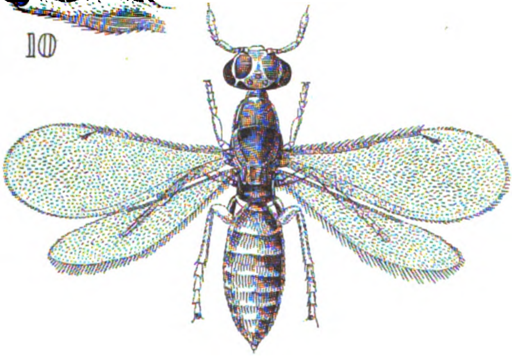
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PLATE IV.

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

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	Assistant Chemist
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DIVISION OF ENTOMOLOGY **BULLETIN No. 7**

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Army Worms and Cut Worms On Sugar Cane in the Hawaiian Islands

By O. H. SWEZEY

HONOLULU, HAWAII
NOVEMBER, 1909

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the Hawaiian Sugar
Planters' Association, Honolulu, Hawaii.

Gentlemen:—I herewith submit Bulletin VII of the Division of Entomology. It has been prepared by Mr. Otto H. Swezey, and is entitled "Army Worms and Cutworms on Sugar Cane in the Hawaiian Islands."

Yours obediently,

G. W. KIRKALDY,
Acting Director, Division of Entomology.

Honolulu, Hawaii, September 1, 1909.

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INTRODUCTION.

There are 35 or more species of cut worms and army worms known in the Hawaiian Islands. Of these, the majority are native and live mostly in the mountains or high plains. Only four of the native species (*Cirphis amblycasis, Cirphis pyrrhias. Feltia dislocata* and *Agrotis crinigera*) have so far become pests in cane fields. The other native species have apparently been kept in check by their parasites and other enemies, or remain at higher elevations than canefields. Some species are quite rare, but others sometimes become abundant locally.

Besides the four native species mentioned above, the other species treated of in this circular are cosmopolitan, occurring in most of the warmer parts of the globe. They are pests, wherever known. The army worm (*Cirphis unipuncta*) is undoubtedly the worst one of them, in the cane fields here. But usually to be found amongst these are one or more of the species above mentioned, though these latter usually are not nearly so numerous as the former, and probably the most of the injury to the cane is done by the army worm.

From reports of devastation done by these caterpillars in previous years, apparently they are not nearly so serious a pest at present, though I have seen, during the past three years, fields of young cane very badly stripped by them, and hence kept back for a while at the beginning, when it was desirable for it to be getting a good start. The critical time for the cane is when it first comes up. If the army worms are numerous, they will probably eat the leaves from the young shoots as fast as they appear. Since the growing heart of the cane-shoot is within, and lower down than where they attack it, the shoot is not killed outright, as would be a tomato, cabbage or tobacco plant if cut off at the surface of the ground; hence, their work in cane fields is not so disastrous as in many other crops. The young shoots of cane, although temporarily checked, eventually reach a growth beyond the attack of the caterpillars, higher than they will climb.

The various species of caterpillars may be readily identified by comparing them with the figures on the plates, likewise the moths, more satisfactorily than from descriptions.

THE ARMY WORM.

Cirphis unipuncta (Haworth).

(Plate III, Figs. 3-6.)

Leucania unipuncta, Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 142, 1901.

Heliophila unipuncta, Dyar, List of North American Lepidoptera, p. 161, 1902.

Cirphis unipuncta, Hampson, Cat. Lep. Phal. British Mus., V, p. 547, 1905.

"The moth is variable in size, the average individual measuring about 40 mm. (an inch and a half) in wing expanse. The front wings are pointed at the tips, and are of a reddish grey or fawn color, much specked with black atoms. Anterior of the center of each wing are two rather large, indistinct spots, distinguished from the rest of the wing by an absence of black specks, and by a clearer reddish coloring. Immediately posterior to the outermost of these spots is a white point indistinctly surrounded by blackish. A series of black points parallel with the outer margin; one on each vein is usually perceptible. An oblique black streak starts from this line of dots, and ascends to the apex of the wing, and, with the form of the wings, principally characterizes the species. Just inside the fringe is a serious of black dots, one between each two veins. The hind wings are translucent, grey, with the terminal border and the nervures blackish (in the front wings the nervures are whitish). The sexes differ from each other but little.

"The under side of the wings is of an opalescent yellowish white. Along the outer margin, particularly of the hind wings, are many black specks, so nearly confluent as to form a definitely limited dusky terminal band. On the costal margin of each forewing, near the tip, is a small, distinct, black dot, and at the center of each hind wing is a similar dot. The body is concolorous with the wings, and the legs are light grey, slightly tinged with reddish, and speckled with black dots." [Riley, Third Report of the U. S. Entomological Commission, p. 103, 1883].

Neither in this description, nor in any other of the numerous descriptions I have seen of this species, is mention made of the tuft of long hairs which occurs on each side of the abdomen of male, at base. I sent specimens to Dr. Dyar, who verified my identification of the species, and replied that the structure of the male tufts was the same as in North American specimens. Apparently these tufts were overlooked by Hampson, for in his arrangement of the species of *Cirphis*, he places *unipuncta* amongst those not having these tufts of hair in the male.

This insect occurs as a pest in many widely separated parts of the globe. In the United States it is a bad pest on corn and other cereals. It ranges from Canada south to all southern parts of North America, West Indies, and then South America to Argentina and Chile. It occurs in Madeira, Azores, Britain and South Europe; Southeastern Siberia, Japan, China, India, Malay Islands, Australia, and New Zealand. It has sporadic outbreaks, when it is extremely destructive to grass and farm crops devastating whole fields and travelling in army-like migrations to others adjacent. Fortunately there are numerous parasites, which keep it in check for most of the time; but for unexplained reasons there are times when they increase beyond the control of parasites and predators, and are temporarily very destructive, until again checked by the increase of the parasites.

In these islands, they usually occur in the lowlands and grassy regions; and when abundant in sugar cane fields it is those fields which adjoin fields of grass, or which have more or less grassy gulches in them, or in fields which have been recently planted on land that had lain fallow and had grown up with grass and weeds, or had been in pasture for a time. Although the moths breed more or less the year round, they are more prolific, or breed more favorably during the so-called winter months, November to April. In many districts there is more rain during these months and growths of grass occur favorable for the feeding of the caterpillars. At this time of the year, in fields of young cane situated as above designated, they often are present in sufficient numbers to severely check the growth of the cane. They, in connection with other cut worms, sometimes strip the leaves of the cane, leaving nothing but midribs. This may be only in certain parts of the field, or it may be over a considerable area of it. As the caterpillars feed for about three weeks or a month, while getting their growth, the cane will be checked for this length of time; but after the caterpillars of one brood have become full-grown and cease feeding, there will be a period of a few weeks before the next brood, so that the cane will have a chance of recovery, and the larger it gets the better is it able to withstand further attacks.

LIFE HISTORY AND HABITS.

The egg of the army worm is spherical, smooth, white, and opaque when first laid, becoming faintly iridescent and more sordid before hatching. Its average diameter is 0.6 mm. The eggs are usually placed at the base of the leaves or thrust in behind the leaf sheath, but may often be deposited amongst trash or debris as well. The eggs are glued on to the objects, wherever they are deposited, and are commonly in rows of 15 to 20; but sometimes they are as few as 2 or 3, and again as many as nearly a hundred may be in one batch. The moths deposit their eggs in the early part of the night, even before dark sometimes. One female may deposit several hundred eggs (500-700) and may occupy two or more evenings so doing.

The eggs hatch in a week or ten days, depending on the temperature. The young caterpillars first crawl by a looping motion on account of the fact that the first and the second pairs of abdominal prolegs are rudimentary. After the first molt only the first pair are rudimentary, and after the second molt all prolegs are functional and the caterpillar crawls in the normal manner. There are five molts at intervals of three to six days, and the growing period is thus about three to four weeks, depending on the temperature. The caterpillars usually feed on the plants at night-time and hide during the day beneath leaves or trash on the surface of the ground, or in the soil a little below the surface, or sometimes even remain on the plant and feed more or less or hide in a fold of leaf or behind a leaf sheath or other convenient place. Those feeding on the leaves in the daytime drop to the ground on the slightest disturbance and coil up, remaining motionless for a time. The feeding of the army worm is not like some of the cutworms in that it feeds on the leaves instead of eating the stem of a plant and thus cutting it off at or near the surface of the ground. The evidences of their feeding on sugar cane are easily detected; the lower leaves of the young cane-shoots being notched and ragged where they have eaten the blade of the leaf, and when numerous, in fact the blades of the leaves entirely eaten away, leaving nothing but the hard midribs.

The full-grown caterpillar (Plate III, fig. 4) is 35-40 mm. long, or about one and one-half inches. General color greenish brown with longitudinal blackish stripes on back and sides, much paler below. The stripes are as follows: a wide, pale blackish stripe on the back with an interrupted white line in the middle; outside of this is a narrow pinkish brown stripe; then next a still wider blackish stripe darker along its lower edge, which contains the black oval spiracles, or breathing pores; below this is another pinkish brown stripe having whitish lines on each edge. The head is pale brown, each lobe with a network of darker brown and running up and down in front are two blackish bands diverging below. First segment behind head nearly all brown dorsally. A dark brown spot on outer side of each proleg. Hairs small, situated in inconspicuous tubercles.

The coloration varies somewhat and the stripes are sometimes less distinct. The younger stages are colored about the same; often paler, and sometimes nearly black.

When full-grown, the caterpillar burrows into the soil and at a depth of two to four inches constructs an oval earthen cell, within which after a few days it transforms to the pupa (Plate III, fig. 5). The pupa is of a shiny dark brown color, about 18 mm. long and 4.5 mm. thick, rounded at anterior end and tapering posteriorly to a blunt point which is armed with two nearly straight parallel spines, hooked at the tip, and placed near together. There are four other slender hooked bristles, one lateral and another a little dorsal of each of the larger spines (Plate III, fig. 6). The wing-cases terminate roundedly at the apex of the fourth abdominal segment. On the bases of abdominal segments 5, 6 and 7 is a dorsal black line containing a row of 12-20 pits. These segments are movable.

The moth emerges from the pupa in about ten days to two weeks. It makes its way above the surface, and, clinging to some object, its soft wings soon become expanded and dried, and the moth is fully matured, after a period of from six to eight weeks, or sometimes more, according to temperature.

Cirphis amblycasis (Meyrick).

Leucania amblycasis, Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 141, 1901.

Cirphis amblycasis, Hampson, Cat. Lep. Phal. British Mus., V, p. 495, Pl. XCI, fig. 30, 1905.

"Male and female; 38-41 mm. Head and thorax whitish-ochreous, somewhat brownish-tinged, thorax posteriorly with a few blackish specks. Abdomen in male with very long dense expansible pale ochreous lateral tuft attached to a broad spoon-shaped chitinous process rising from basal cavities, and dense yellowish expansible tufts in middle of base beneath. Forewings pale brownish-ochreous, indistinctly strigulated with fuscous or grey; dark fuscous dots near base in middle and on costa, indicating subbasal line; first and second lines indicated by series of dark fuscous dots, second partially double, moderately curved; lower edge of reniform forming a white dot, edged with dark fuscous and followed by a small dark fuscous suffusion; in female orbicular and reniform obscurely defined, pale yellowish-ochreous; a wedge-snaped faint darker suffusion on termen beneath apex, not reaching second line. Hindwings light greyish-ochreous, irregularly suffused with fuscous, becoming darker fuscous posteriorly." [Meyrick, Fauna Hawaiiensis I. Pt. III, p. 141, 1901].

I have usually found the caterpillars of this moth feeding on various grasses of the lower lands; but I have also found a few of them along with *C. unipuncta* and other caterpillars in the higher cane fields of the sugar plantations of the Hamakua and Hilo districts of Hawaii. I have never found them numerous enough of themselves to be injurious.

It is a native species and the moth closely resembles *unipuncta.* It differs however in being a little larger and the body more plump; has a faint reddish tinge, and the forewings lack the fuscous line which *unipuncta* has, extending obliquely inward at apex. The caterpillar, also, is a little larger than that of *unipuncta.*

The full-grown caterpillar is about 38 mm. It is usually cream colored with pale brownish mottlings; a more or less distinct fuscous mid-dorsal stripe, pale-centered; a wide dark fuscous sub-dorsal stripe, concave on upper edge in each segment, connected by transverse bar on segment 12; a wide supraspiracular stripe of fuscous mottlings, below this a pale yellowish line; prolegs with dark fuscous spot on outer side; head very pale brownish with minute fuscous reticulation, vertical fuscous spot in middle of paraclypeus, a wide fuscous border to inner edge of each cranial lobe; eyes black, a fuscous line extends upwards, and another obliquely backward from them; cervical shield much spotted with dark fuscous, traversed by a median white line and a sub-dorsal white line on each side; spiracles oval, black; tubercles minute, black; a roundish black spot on segments 3 and 4 a little above line of spiracles.

The caterpillars become full-grown in about a month from the hatching of the eggs. Like *unipuncta*, they may often be found on their foodplant in the daytime; in cane, hiding behind the leaf-sheaths.

Pupation takes place in an earthen cell a little below the surface of the ground, or beneath stones or rubbish. The pupa is about 19 mm. long by 5 mm. thick; medium brown, darker on the back, eyes nearly black; a row of about a dozen pits on dorsal side at base of abdominal segments 5, 6 and 7; apex of abdomen pointing a little ventrally, with two slightly diverging, pale spines, dark at base, curved ventrally and hooked at tip, a curved hooked bristle a little dorsally, and another a little laterally from each of these terminal spines. The moth emerges from the pupa in about two weeks.

Cirphis pyrrhias (Meyrick).

Leucania pyrrhias, Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 141, 1901.

Cirphis pyrrhias, Hampson, Cat. Lep. Phal. British Mus., V, p. 494, Pl. XCI, fig. 28, 1905.

"Male and female, 39-46 mm. Head and thorax brown-reddish irrorated with whitish-ochreous. Abdomen densely hairy towards base, in male with dense expansible brownish-ochreous tufts at base beneath, and also in lateral basal cavities. Forewings pale brownish-ochreous, densely suffusedly strigulated throughout with brown-reddish; veins posteriorly ochreous-whitish, sprinkled with dark fuscous; costal edge sometimes white; first and second lines formed by series of indistinct dark fuscous dots, second rather strongly curved; lower end of reniform forming a small white dot, followed by a dark fuscous suffusion. Hindwings light rosy-ochreous." [Meyrick, Fauna Hawaiiensis, I. Pt. III, p. 141, 1901].

This is a native moth usually living in the native forest regions above cultivated lands. The caterpillars normally feed on grasses, commonly Hilo grass; and on sedges, particularly *Baumea meyenii,* a large equitant-leaved species growing on the mountain ridges at elevations of 1000 feet and more. The caterpillar may often be found on the leaves of this plant, or hiding in the dead leaves and trash at its base. I have observed a few of them in the higher parts of the sugar cane plantations of the Hamakua and Hilo districts of Hawaii, where they were feeding on the young cane along with army worms and other cutworms. They have the habit of hiding behind the leaf-sheaths of the cane, in the daytime, as the caterpillars of *unipuncta* often do.

The moth is easily distinguished from the two preceding species as it is of a distinct reddish color, especially the forewings. The caterpillars are larger and plumper than those of *unipuncta,* and a little larger than those of *amblycasis.*

I once found about a dozen eggs of this moth in a row on a leaf of Hilo grass (*Paspalum conjugatum*). They were white, spherical, with a faint miscroscopical reticulation, about 1 mm. in diameter, distinctly larger than eggs of *Feltia dislocata.* The larvae from these eggs became full-grown in about a month. They molted five (possibly six) times at intervals of three to five days. The pupal stage occupied about three weeks.

The full-grown caterpillar is 42-45 mm.; olivaceous, with faint rosy tinge in places; head reticulated with brown; cervical shield traversed longitudinally by three whitish lines bordered on both sides by blackish; the whitish lines are faintly continuous on the body, the mid-dorsal one somewhat interruptedly bordered with brownish fuscous, each lateral one forms the lower boundary of an interrupted dark, brownish-fuscous subdorsal stripe; just above line of spiracles a much interrupted wide brownish-fuscous stripe, more distinct posteriorly and extending onto posterior proleg; other prolegs with a large blackish spot on outer side; tubercles; forming two rows of black dorsal dots; other tubercles not conspicuous; hairs short, pale; spiracles oval, black; a black dot in line with them on segments 3 and 4. Younger caterpillars are often paler; and in some of them the dark stripes are more conspicuous.

The pupa is formed a little beneath the surface of the soil, or under trash. It is about 22 mm. long by 6.5 mm. thick; medium reddish brown, a little darker on the back; near basal dorsal margin of abdominal segments 5, 6 and 7 is a transverse row of about twenty pits situated in a black line; apex of abdomen very blunt, cremaster slightly projecting near dorsal side, with two slender, slightly diverging, pale spines, black at base, curved ventrally and hooked at tip; a curved, hooked bristle a little dorsally, and another a little laterally from each of these spines; wing-cases, etc. extend to apex of fourth abdominal segment.

THE GRASS ARMY WORM.

Spodoptera mauritia Boisd.

Plate II, figs. 7-11.

"Dark grey-brown with a rusty tinge; abdomen fuscous. Forewing with the sub-basal, antemedial, and postmedial double waved lines indistinct; the orbicular small and ochreous; the reniform blackish; the submarginal line whitish and irregularly waved; a whitish patch is often present between the orbicular and reniform and a dark patch on the central marginal area. Hind wing opalescent and semihyaline white, with a dark marginal line." [Hampson, Fauna of British India, Moths, II, p. 248, 1894].

This moth occurs in Mauritius, West Africa, and throughout the Oriental and Australian regions. Its caterpillars were formerly a very serious pest in the grass lands and sugar cane fields of the Hawaiian Islands; but their numbers were greatly reduced by the introduction of the Mynah bird. Now they are no longer a serious pest, though they are often numerous in grass, where the Mynah birds may be seen searching for them; but before the Mynah bird was introduced, it is reported that often whole fields of young sugar cane were eaten by them; and that the grass slopes in the valleys and mountains would be entirely consumed by them at times; in fact, they were in millions and behaved much like army worms. Besides feeding upon grasses and sugar cane, they also eat corn, peas, beans, and probably other kinds of garden plants.

During January and February, 1906, they caused considerable trouble at the Experiment Station by attacking the tiny cane seedlings which were being propagated. It required daily examination, and careful search, for the tiny larvae were green like the leaves; and although small, yet were big enough for one of them to soon destroy one of the little cane seedlings (which were 1-2 inches high) if not detected soon after it had started feeding. Fortunately they did not work after the manner of cutworms and cut a plant off immediately. Instead, they began eating at the tips of leaves, and they could be first detected by the dried remains of tips of leaves where they had fed, then closer looking would reveal the tiny green caterpillar, which on being disturbed dropped to the ground and could be readily killed. Usually but one caterpillar was found on one seedling; but sometimes more, even as many as four, in which case they soon destroy the plants.

LIFE HISTORY.

The eggs (Plate II, figs. 10, 11) are spherical, slightly flattened at base where in contact with the object upon which they are deposited. They are dirty whitish or gray in color, and densely striated vertically. They are usually in large masses of one layer and in regular rows, and covered with gray hairs from the abdomen of the moth. There may be from 100 to 300 in one cluster. One moth may lay several hundred eggs; one specimen which I had in a breeding cage laid 700. The egg masses are not placed necessarily on the food plant; but usually high up, often on the leaves of banana and small palms, or other small trees or shrubs at three to five feet elevation. It is also common to find them on the sides of buildings and other structures. In one instance I found a batch of eggs ten feet up on the side of a building. The eggs hatch in three to four days from the time they are laid, and the tiny larvae drop to the ground by means of a silken thread, where they will find grass or other suitable food plant. They feed at first at the tips of leaves, eating the green substance of the leaf and leaving the epidermis, which dries up, giving a dead appearance. When a few days old, they eat the entire substance of the leaf from its margins, producing notches and a very ragged appearance.

After molting five times at intervals of two to six days, the caterpillars become full-grown in two to three weeks (Plate II, figs. 8, 9). They are then about 1.3 inch long (35 mm.). They vary a great deal in coloration. Some are nearly uniform grass green with median dorsal and sub-dorsal white lines; others are nearly black, with a sub-dorsal stripe and a stripe on line with spiracles darker than the rest, and a yellowish (sometimes pinkish) stripe below spiracles, underside pale. There are all gradations between these two. A common form is green with the sub-dorsal and spiracular stripes black; another form has the stripes broken up into a series of black spots, one spot to each segment. The spiracles are always black, and in the black form there is a white dot a little above and behind the spiracle on segments 5 to 12. Hairs minute. Tubercles inconspicuous.

The pupa is formed in an earthen cell a little below the surface of the soil. It is medium dark brown, a little more than half in inch in length (12 to 15 mm.). At its apex are two straight slender-pointed spines set rather wide apart and nearly parallel.

The moth emerges from the pupa in eight to fourteen days, and is ready for egg-laying in two to four days. Thus the whole life cycle occupies only five to six weeks. With wings spread, the moth is 1.25 to 1.50 inches (30 to 35 mm.). The fore wings of the female are a dark gray with darker waved lines crossing at one-third and two-thirds from the base, a row of triangular black dots on terminal margin, and two or three marks a little before terminal margin. A little before middle of wings is an oval yellow spot. The hind wings are whitish with brown on margins and veins. The forewings of the male are much paler than those of the female and have varying shades of very pale brown; the lines and markings are more distinct.

THE LESSER NATIVE CUTWORM.

Feltia dislocata (Walker).

(Plate II, Figs. 3-6.)

Agrotis dislocata, Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 146, 1901.

Feltia dislocata, Hampson, Cat. Lep. Phal. British Mus., IV, p. 351, Pl. LXVIII, fig. 12, 1903.

"Male and female; 34-47 mm. Head and a marginal band along front of thorax light ochreous-brown, rest of thorax whitish-fuscous. Antennae in male bidentate with triangular processes. Forewings light fuscous, more or less irrorated with white, and sometimes darker-sprinkled; veins marked with dark fuscous lines, except lower margin of cell, which is white; interior of cell paler and more ochreous, usually marked with a black dot towards base; orbicular and reniform combined into an elognate posteriorly abruptly dilated mark, fuscous, outlined with black; a darker fuscous black-outlined streak beneath cell from base to middle, somewhat dilated posteriorly; a pale ochreous longitudinal suffusion beneath this from base to near tornus; sometimes short undefined blackish dashes or dark-outlined marks between bases of veins 2-6. Hindwings fuscous." [Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 146, 1901].

This is a native cutworm and often becomes a bad pest in sugar cane, as well as in gardens and also on other crops. From my observations, it is more injurious to garden crops than to cane; but they are often reported numerous locally in cane fields. I have often taken them in cane fields in company with the army worm (*Cirphis unipuncta*). They are slightly larger than the latter, and have more strictly the cutworm habit of feeding; that is, of hiding during the day in the soil or under trash and rubbish on the surface of the soil, and feeding at night on the lower leaves of the plant.

LIFE HISTORY.

The eggs (Plate II, figs. 5, 6) are laid at the base of plants, or even scattered on the soil, sometimes singly, sometimes two or three adhering together, and sometimes as many as a dozen in a bunch together or even a hundred or more in an irregular one-layed mass. They are of a yellowish white color, nearly spherical, 0.8 mm. in diameter, minutely reticulated at upper pole and radiately ridged from it down the sides.

They hatch in a week or ten days. The caterpillars molt five times at intervals of four to six days, attaining their full-growth (36-40 mm.) in three to five weeks (sometimes much longer than this in hot, dry seasons).

The full-grown caterpillar (Pl. II, fig. 4) is of a dirty brownish color, with a broad lighter brown stripe on the back; under side dirty whitish. Tubercles black, a row of them on each side of the dorsal lighter stripe, are larger and more conspicuous than the rest. Hairs short, black. Spiracles oval, black. Head rather small proportionately, brown with blackish spot above each eye cluster, and two black bars in front converging above. The dorsal part of first segment behind head very dark brown. The full-grown caterpillar forms an earthen cell in the ground a few inches below the surface. After four to six days it transforms to the pupa which is similar in form to the pupa of *Cirphis unipuncta*, about 17 mm. long, and of a pale yellowish brown color. The moth appears in 15 to 20 days, which makes a period of about two months from the time eggs were laid.

The moth (Pl. II, fig. 3) with wings expanded is about 1½ inches, or 40 mm. It is of a whitish grey color. The fore wings have a longitudinal white streak for more than half their length, behind which is a shorter blackish streak, which in turn has a yellowish streak behind it. The veins are marked with dark lines, and there is a row of dark dots on termen. Hind wings a little darker, with pale fringe. The wings when at rest are held straight backward over the back, often tipped so as to lie close along the sides of abdomen.

THE LARGER NATIVE CUTWORM.

Agrotis crinigera (Butler).

Plate II, figs. 12, 13.

"**Male and female, 49-54 mm. Head and front of thorax brownish, rest of thorax light fuscous. Antennae in male filiform. Fore-**

wings long, rather narrow; light fuscous, darker-sprinkled, sometimes partially faintly rosy-tinged; subbasal and first lines obscurely pale, dark-edged, first irregularly waved-dentate, very acutely on vein 1b; median thick, cloudy, dark fuscous, slightly curved; second with dark inner edge acutely waved-dentate, outer faint or obsolete, regular; orbicular oval, dark-centred, dark-outlined; reniform dark-suffused, including three obscure paler transverse marks, resting on posterior edge of median line; claviform faintly indicated, narrow, elognate; subterminal line sometimes faintly paler, faintly darker-edged anteriorly. Hindwings light fuscous. [Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 148, 1901].

This is another native cutworm. and is often a bad pest. It sometimes occurs in sugar cane; but more often attacks other vegetation rather than grasses and cane. It is fond of garden peas and beans and other garden plants. and I have found them abundant in fields of cow peas. I have also found them feeding abundantly on a native shrub (*Sida*), also on several kinds of weeds as *Portulaca* and *Datura* ("Kikania"). The caterpillars usually hide in the soil or below debris in the daytime; but I have frequently observed them feeding on the plants in the daytime, and have also found them hiding among the leaves.

LIFE HISTORY.

The egg-laying habits are unknown. From very small caterpillars which I have found and reared, I estimate that it takes the caterpillars about one month to six weeks from hatching till they are full-grown. They are then 45 to 50 mm. in length and are more plump than other cutworms; in fact, this is the largest of our common cutworms.

The full-grown caterpillar (Plate II, fig. 13) is quite similar to that of *Feltia dislocata*, but quite a bit larger; more blackish above, and paler below; the tubercles are not so conspicuous, the row below spiracles pale instead of black. The head lacks the black spot above eye cluster.

The pupa is formed in an earthen cocoon 30 mm. by 15 mm. It is 21 to 25 mm. long; light brown in color, darker on the back. The pupal period is 21 to 25 days, thus the life-cycle from egg to adult moth is probably a little more than two months, occupying a little longer period than the other common species on account of its larger size.

The moth (Plate II, fig. 12) measures two inches with its wings spread. It is of a brownish grey color, the male paler than the female. The male also has large tufts of yellowish hairs at the apex of the abdomen. The fore wings have some darker markings, viz., a roundish area a little anterior of the middle of the wing, an oval ring a little nearer to the base, a zigzag line across the wing about one-third the distance from the base, another zigzag line about three-fourths from the base, a row of triangular dots at termen. Hind wings nearly uniform very pale brown, a little darker on the veins.

THE BLACK CUTWORM.

Agrotis ypsilon (Rottenburg).

Plate II, figs. 1, 2.

"Head and thorax red-brown, the latter suffused with fuscous; frons with blackish bar above; back of head with two black spots; tegulae with brown and black medial band; pectus whitish; tibiae and tarsi ochreous white and black; abdomen grey-brown. Fore-wing ochreous irrorated with brown; the costal area suffused with fuscous brown, and often the whole wing to the postmedial line; a double, waved, subbasal line from costa to the submedian fold; a double, waved antemedial line dentate inwards on median nervure and vein 1 and outwards above inner margin; claviform moderate or small, defined by black; orbicular and reniform defined by black and with fuscous centres, the fomer small, elliptical, or with its outer edge produced to a point, the latter with wedge-shaped black spot from its outer edge; an indistinct dentate medial line; a double minutely dentate postmedial line produced to points on the veins, bent outwards below costa, excurved to vein 4, then incurved; a subterminal series of pale and black dentate marks, those above veins 4, 5 with the black on their inner side stronger and some fuscous suffusion on their outer; the veins towards termen with dark streaks; a terminal series of points. Hind wing semihyaline white, the veins, costal and inner areas, and termen tinged with brown, strongly in female and in the New Zealand form." [Hampson, Catalogue of the Lepidoptera, British Museum, IV, p. 368, 1903].

This is a well-known garden cutworm throughout the United States. It ranges in America from Hudson Bay south to Uruguay; is common in Europe; also occurs in northern and southern Africa, India, China, Japan, Java, Australia and New Zealand. It is a typical cutworm in its feeding habits,

i. e., feeding on plants at night-time, often cutting off small plants at or below the surface of the soil, and hiding under leaves, trash, or burrowing in the soil during the daytime. It is a very general feeder, attacking nearly all kinds of garden and field crops, and even weeds. I have never found it very abundant in cane fields, nor have I known of it being reported so, though it does frequently occur along with the other species and is partially responsible for the damage done. I have found them in fields of young cane, when no evidence could be found of their having eaten the cane. They were beneath plants of pigweed (*Purslane*) upon which they must have fed. In the United States they are particularly troublesome to corn, cotton, cabbage, tomato, and tobacco, attacking the young plants, one cutworm often destroying several plants in one night. In India they are destructive to young tea and coffee plants and opium.

LIFE HISTORY.

The eggs are domeshaped, about 0.5 mm. in diameter, and creamy white in color. There is a small circular depression at the upper pole from which radiate numerous ridges running down the sides to the base or surface in contact with a leaf. The eggs are laid on the surface of leaves or stems of plants near to the ground. From one to many eggs may be placed close together in one batch, and one moth may produce several batches amounting to two or four hundred eggs.

The larvae hatch from the eggs in a few days (usually two to four). They molt five times at intervals of two to six days and become full-grown in about one month. The full-grown caterpillar (Plate II, fig. 2) is about 1.75 inches long (45 mm.). It is of a nearly uniform dark greasy gray color, paler below. The spiracles are black. The tubercles are conspicuous, showing as regular rows of brownish dots. Head and dorsal part of segment behind head dark brown.

The pupa is formed in an earthen cell a little below the surface of the soil. It is about .75 inch long (20 to 23 mm.), uniform medium brown in color, with a dark dorsal band at apex of abdominal segments 4, 5, 6 and 7, containing irregularly arranged small pits. At the tip of abdomen are two large tapering spines, black at base and pale at tip, a little distance apart at base, slightly diverging but curved together at their tips.

The moth (Plate II, fig. 1) emerges from the pupa in ten days to three weeks. It is about two inches in expanse of wing.

THE VARIEGATED CUTWORM.

Lycophotia margaritosa (Haworth).

Plate III, figs. 1-2.

Agrotis saucia, Meyrick, Fauna Hawaiiensis, I, Pt. III, p. 143, 1901.

Peridroma margaritosa, Dyar, List of North Amercan Lepidoptera, p. 134, 1902.

Lycophotia margaritosa, Hampson, Cat. Lep. Phal. British Mus., IV, p. 536, fig. 92, 1903.

> "Head and thorax brown mixed with ochreous; palpi fuscous except towards extremity; thoracic crest often whitish; abdomen grey-brown. Fore wing brownish ochreous irrorated with brown; a double waved subbasal line from costa to vein 1; a double waved antemedial line; claviform moderate, with brown outline and line in centre; orbicular and reniform large with brown outlines, the former elliptical, the latter with fuscous in its lower portion; the postmedial line dentate and produced to points on the veins, bent outwards below costa, excurved to vein 4, then incurved; the subterminal line ochreous, angled outwards at vein 7 and dentate at veins 4 and 3, with fuscous spots on its inner side at costa and on its outer from below apex to middle; a terminal series of small dark lunules. Hind wing semihyaline white, the veins and marginal areas brown; the underside with discoidal point and the costal area irrorated with brown." [Hampson, Catalogue of the Lepidoptera, British Museum, IV, p. 536, 1903].

This is another cosmopolitan cutworm, being widely distributed over Europe, Asia, North Africa, North and South America, from Canada to Argentina.

It is a general feeder, eating the usual garden and field crops and not particularly grasses. It is also a green-house pest in the States, feeding largely on violets and other ornamental plants. In the Hawaiian Islands, besides feeding on garden crops it also feeds upon sugar cane to some extent, being frequently found in cane fields along with the army worm. Brother Matthias Newell of Hilo has reared them on orange leaves, from an egg mass found on an orange leaf. They also feed upon some common weeds. I have found them quite numerous on "pualele" (*Sonchus*), and occasionally on "kikania" (*Datura*), *Xanthium* and purslane. They often remain feeding on the plants in daytime.

LIFE HISTORY.

The eggs are deposited in regular masses, often in regular rows on the surface of leaves or twigs, usually a large number in a mass, often several hundred. The egg is about .6 mm., hemispherical, flattened on the surface in contact with the leaf or twig. It is radiately ribbed from the upper pole, and has minute cross ribs between these. The young larvae are green with black heads. They molt five times before attaining their full growth, which takes about a month or a little more.

The full-grown caterpillar (Plate III, fig. 2) is about 1.75 inches (40-45 mm.). It varies much in color. Head pale brown, reticulate with dark brown, a slight line upward from eyes, two curved vertical broad dark bands in front. Body brown, more or less generally mottled with darker and lighter brown and some yellowish; dorsal line pale yellowish often broken into a series of yellowish patches on segments 4-7, (sometimes on segments 3-9); segment 12 mostly yellow dorsally on posterior part; a yellowish line below the spiracles, which are black. Tubercles and hairs very minute. In darker forms the browns are nearly black. There is a more or less irregularly interrupted blackish streak just above the line of spiracles. A sub-dorsal line consisting of blackish spots on each segment. On several of the segments there is a dorsal lozenge-shaped spot slightly darker than the general color, but not so dark as the blackish stripes. A blackish spot on outer side of each proleg.

The pupa is formed in the ground a few inches below the surface, or beneath trash. It is 19 mm. in length, and of a uniform medium brown color, its apex armed with two spines very close together, the basal half of each spine black, the tips white. The moth appears in two or three weeks.

This moth (Pl. III, fig. 1) measures 1.75 to 2 inches (45-50 mm.), with wings spread. It is of a pale grayish-brown, tinged faintly with reddish. The fore wings are shaded about the middle and toward the outer margin with darker brown, and a row of dark triangular dots on the outer margin. There are two roundish-oval lighter spots a little forward of the middle of the wing. The hind wings are paler at base, and darker about the margins and on the veins.

REMEDIES.

The ravages of army worms and cutworms may be checked by poisoning them. One method is to spray the poison onto the plants in liquid form. For this, Paris green may be used, or Disparene; the former at the rate of one-half pound per 50 gallons of water; the latter at the rate of two pounds per 50 gallons of water. The most general practice in these Islands is using poisoned bait. For this, Paris green is mixed with bran or middlings. To make this, add two or three ounces of sugar or molasses per gallon of water, then stir in bran at the rate of about one pound per gallon of water. Thoroughly mix poison with this at the rate of one pound per 50 pounds of the moistened bran. The mixture is to be scattered throughout the infested regions. The mixture may be made dry, using one pound of Paris green to 20 pounds of bran and middlings mixed in equal parts. Another method of applying poisoned bait is to spray with poison some green crop as grass, clover, or alfalfa; then cut this and scatter in the infested regions, preferably late in the afternoon, so that it will not become too much wilted before the cutworms feed upon it in the evening. The advantage of using poisoned bait in a cane field is that the cutworms hiding in the ground during the day are most likely to eat the poisoned bait when coming forth at night to feed, rather than climbing the young cane shoots to feed on their leaves.

NATURAL ENEMIES.

BIRDS.

One of the best checks to the increase and ravages of the army worms is the mynah bird. This bird was introduced from India about twenty or more years ago, for the very purpose of feeding upon army worms and cutworms. Although it has some other undesirable habits, yet it is very valuable for this purpose. It has increased probably to its maximum limit, and is perhaps at present somewhat reduced in numbers on account of the lack of Lantana berries which at one time formed a large part of its diet.

It is to be found practically everywhere throughout the Islands, at least the habitable and cultivable portions. With its increase has come the decrease in devastation by army worms and cutworms; whereas previously it is reported that whole fields of young cane were stripped off by the great numbers of caterpillars, and that grass lands of great areas were likewise totally eaten off, particularly by the grass army worm (*Spodoptera mauritia*), in recent years the damage has been slight compared with formerly.

The golden plover (*Charadrius fulvus*) also lives largely on these caterpillars. They come from Alaska to these Islands for the winter season, coming in August and remaining till the following April. Before leaving they become very fat from their cutworm diet. In regard to their habits, I quote from Dr. Perkins in Fauna Hawaiiensis:

> "In many parts of the Islands large numbers of plover habitually resort to the margin of the sea and the extensive mud-flats for feeding purposes, but the greater part scatter over the lower-lying grass lands and the open mountain country, where they may be found even as high as five or six thousand feet above the sea. In such localities they find abundant food in the caterpillars of various Noctuid moths, and indeed in the moths themselves. Of all the Island birds the plover is beyond question the most valuable to the grazier and the agriculturist, and it is singularly unfortunate that it is a most excellent bird for the table, and at the same time the one most generally sought after by sportsmen.
>
> "I have been at some pains to learn exactly the species of Noctuidae which form the favorite food for the plover, whether as moth or caterpillars, and I have several times shot the bird at the instant that it has seized a moth in its hiding-place at the roots of grass. I am therefore able to state positively that it catches the moth both of *Agrotis crinigera* and *dislocata*, the caterpillars of which are the two most extremely injurious and wide-spread of all the Island 'cutworms.' It also obtains the caterpillars of both these and other species and feeds, as is well known, to an enormous extent on the grassy army worm (*Spodoptera mauritia*), a caterpillar which not

only locally entirely clears off the freshly grown grass, but also does some damage to the young leaves of sugar cane.

"For these reasons the plover is worthy of all encouragement by the agriculturist and should never be shot on or around his land, or, if this is done, he should not complain when his crops are ravaged by cut-worms, as is often the case."

The English sparrow is abundant on Oahu, though not on all the other Islands, and has been observed to prey upon army worms to some extent.

TACHINA FLIES.

These parasites are very valuable in helping keep cutworms and army worms in check. They prey upon numerous other kinds of caterpillars also; I have reared one species from fourteen species of caterpillars, and another from eleven species.

There are eight native species of cutworms of the genus *Leucania,* and 24 species of the genus *Agrotis.** The most of these are rare, and are probably kept so by these parasites. They are found common on all of the Islands, and where cutworms or army worms are numerous they will be found numerous also. I have collected caterpillars in quantity in cane fields in different parts of the Islands and examined for maggots of these parasites, and often found as many as 25% to 35% of them parasitized. In one lot sent to the Experiment Station from Hamakuapoko, Maui, 70% were parasitized.

Frontina archippivora (Williston).

The habits of this species are given on pages 47 to 49 of Bulletin V, Experiment Station, H. S. P. A., Division of Entomology. It is figured on Plate VI, fig. 4.

Caetogaedia monticola (Bigot).

Plate III, figs. 8-13.

Bigot, Ann. Soc. Ent. France, (6) VIII, p. 91, 1888.

This large Tachina fly was described from the Rocky Mountains; has also been reported from California. It occurs throughout the Hawaiian Islands, on the lowlands and well up into the mountains. They are found common wherever army worms or cutworms are numerous. In examination of numerous army worms collected at different times from several different districts, not so many were parasitized by this Tachina as by *Frontina archippivora*, yet a good many were; and of the rarer native cutworms which I have obtained specimens of from time to time, more were parasitized by *Chaetogaedia* than by *Frontina;* in fact, it is difficult to get specimens of some of the native cutworms which are not parasitized. Other species of caterpillars are also parasitized by this Tachinid. I have reared it from 11 different species of caterpillars.

---

* **As given by Meyrick in Fauna Hawaiiensis.**

This fly is much larger than a house fly, and of much the appearance of the large grey flesh fly, from which, however, it may be readily distinguished by its habits and flight. It is more solitary, and does not frequent decomposing substances.

The following observations on the habits of this fly were published by the writer in the Proceedings of the Hawaiian Entomological Society, II, No. 1, pp. 7-9, Oct. 1908. [Paper read at March meeting, 1908].

"It is but recently that I discovered the method of egg-laying of this fly. It is usually stated in entomological literature that Tachina flies lay their eggs on the bodies of their hosts; in fact with certain species the act has been observed. but for far the greater number of them the act of egg-laying has not been observed, or at any rate not recorded. That *Chaetogaedia* had a different method of laying eggs was surmised, when in June. 1907. this parasite was reared from more than half of a lot of pupae of *Agrotis cinctipennis*, one of the less common native cutworms. The eggs of this lot of cutworms were hatched in breeding cage and grew to maturity without the possibility of access of a Tachina fly; hence, considerable of a mystery arose when more Tachinids than moths bred out from the lot.

"This mystery was not cleared up till in February, 1908, when in watching a female *Chaetogaedia*, as I supposed, hunting for caterpillars amongst grass and weeds, I observed that she was laying eggs on the grass leaves. She would quickly crawl around among the leaves, only stopping momentarily to place an egg here and there on the surface of a leaf, never more than one per leaf. They were placed on the leaves of weeds as well as on the grass. After making this observation, it was easy to explain how the caterpillars previously alluded to, became parasitized; for they were daily supplied with food (mostly *Sonchus*) gathered from outside where Tachinas were common, and had undoubtedly deposited many eggs on the leaves. The caterpillars ate the leaves with the eggs there-on, which hatched inside and grew to maturity, not, however, killing the caterpillars till after the latter had transformed to pupae.

"I have since learned that another Tachina fly has similar habits of laying its eggs, the "Uji," which is very destructive to silk worm caterpillars in Japan. This is the only instance I have found in entomological literature of a Tachinid laying its eggs otherwise than directly on the host (caterpillar, grass hopper, or whatever it is.)

"The egg-laying habits and the life history of the "Ugi" (*Ugimya sericariae* Rondani) were published in detail by Sasaki, in Journ. Sci. Coll. Imp. Univ. Japan, 1886. The eggs are laid on mulberry leaves, eaten by the silk worms; hatch in the digestive canal in a few hours; the larvae bore thru its walls, feed on the ganglia for a time; later enter the tracheal system and become located in a sort of cup or sac, with the spiracles at the posterior end near a spiracle of the caterpillar and the anterior end with the body cavity where it is convenient to feed on the fat of the silkworm; when fully developed the maggot forces its way out thru the skin of the silkworm (or pupa, if it has pupated); enters the ground to form its puparium, within which it remains thru the winter.

"*Chaetogaedia monticola* agrees with this in some parts of its development. The eggs are laid on leaves as before stated. The egg of *Chaetogaedia* appears as a tiny black dot on a grass leaf. It is .44 mm. long by .25 mm. broad, quite regularly ovate, shaped like a hen's egg only somewhat flattened where in contact with the leaf; smooth and shining black. A female dissected was found to have several hundred of them in the uterus. Another female which bred out in capavity, was dissected when several days old, to count the eggs. The uterus contained 1066 eggs* which were black and apparently ready for oviposition. The ovarian tubes, which are numerous and collected into two ball-like structures, were full of immature ova. Probably the majority that are laid are not eaten by caterpillars; hence, the provision of such a large number is to insure some of them being eaten. They are so small as to escape being injured by the jaws of the caterpillars in biting off bits of leaf, tho probably some are destroyed. They soon hatch in the alimentary canal of the caterpillar and bore thru its walls to the surrounding body cavity. If they did not hatch the same day they would probably pass out with the excrement. A caterpillar which had been fed with leaves on which quite a number of *Chaetogaedia* eggs (dissected from a caught female) had been spread, died after 5 days. It was dissected and 24 maggots of the parasite were found inside. They were about 2 mm. long and were mostly located in the head and anterior segments of the caterpillar. Other caterpillars which had been similarly treated and had died, were dissected and fewer maggots found inside. With so many maggots there is not food enough for all, so the caterpillar dies too soon before the parasites can become full-grown. Perhaps only those caterpillars which have eaten but one egg, or have had but one egg hatch inside of them, are able to survive till the maggot becomes full-grown, and those having more than one maggot inside die too soon, and thus the maggots themselves die; at any rate, I never have reared more than one parasite per host, nor have I found more than one puparium formed per host.

---

* I have since counted 4944 eggs from the uterus of one female.

"In dissecting caterpillars containing maggots, I never have found maggots feeding on the nerve ganglia, as Sasaki has; but I have found them located, as he says near a spiracle of the caterpillar, and enclosed in a sort of sac which is apparently an enlarged tracheal tube, the maggot locating in it when small and the tube becoming enlarged as the maggot grew. Usually there is a blackening of the caterpillar externally where one of these is located. When about full-grown the maggot leaves the sac and lies lengthwise in the caterpillar (or pupa, if it has pupated) eating up all or nearly all of the fatty matter of the latter. It may be nearly full-grown at the time the caterpillar pupates, or it may be still quite small; but I never have known of a case where the puparium of the parasite was formed before the caterpillar had pupated. The puparium is cylindrical, rounded at the anterior end, and rather blunt at the posterior end where it is often somewhat widened. It is of a very dark reddish color, and each of the two spiracular orifices at the posterior end has three black rounded protuberances around it. The anterior end is always directed anteriorly in the host pupa. The adult fly emerges in about 10 to 14 days from the time the puparium is formed."

Shortly after the above was published, I received a copy of Technical Bulletin No. 12, Pt. VI, U. S. Bureau of Entomology, issued Sept. 1908. In this Mr. C. H. T. Townsend gives the results of observations on the habits of tachinids, gathered from the experience of himself and others in rearing imported tachinids at the Gypsy Moth Laboratory, Melrose Heights, Massachusetts.

These results were quite startling. Among the species of European, Japanese and American tachinids dealt with, there were found to be five different styles of reproductive habit; namely: **host-oviposition; leaf oviposition; supra-cutaneous host-larviposition; sub-cutaneous host larviposition and leaf-larviposition.**

As a conclusion from these results, great importance is attached to those species having the leaf-oviposition habit as parasites for the gypsy moth. All of these species produce large numbers of eggs, as high as 5000 having been found contained in the uterus of one species.

During the summer of 1909, I have made the following additional observations of interest on *Chaetogaedia monticola.*

A female (taken in the field) was placed in a cage where there was growing grass on which she might oviposit. She died on the second day, however, without having laid any eggs. On dissection the uterus was found to be filled with a large number of eggs. Some of these were examined, and all stages of development were found, some apparently ready to hatch. Examination was made by placing a number of eggs on a glass slip and applying pressure with the point of a knife blade, when the shells of the eggs would burst with an audible snap and allow the embryos to emerge, many of them without injury. Some of these were still retained in the vitelline membrane, while others were entirely free from it and were to be seen crawling about, which shows that they are fully developed, ready to hatch, before the eggs are laid. This accords with the observations of Townsend and Sasaki. Many of those still enclosed in the vitelline membrane, were seen to be active, wriggling about, revolving and even doubling up, as fully developed as those which had escaped from the vitelline membrane.

Some of the eggs from this same female were retained in a dry condition in a vial. They were examined from time to time, and it was found that at the end of four weeks, there were some of them with living embryos; showing that they undoubtedly may remain alive on the leaves of plants for some little time, if not immediately eaten by caterpillars.

As regards the hatching of tachinid eggs after being eaten by caterpillars, no satisfactory explanation has yet been given. The shell of the egg is so hard that it seems unlikely that it could be sufficiently affected by the digestive juices of the caterpillar, quickly enough to allow the maggot to escape from the egg, and also have time enough to pass thru the wall of the alimentary canal before it would be carried along and be expelled with the frass of the caterpillar—this latter being a rather rapid process in a normally feeding caterpillar.

In my earlier notes, above, I have said that the eggs are so small as to escape being injured by the jaws of the caterpillars in biting off bits of leaf. I quote the following from Townsend on page 109 of the bulletin above referred to: "Furthermore, the chitinization strengthens the egg and thus lessens the chance of injury to it while being swallowed. Still further, we have found that the chorion of all these eggs possesses a minute raised reticulation, which we consider is intended as a framework to strengthen it so as to protect the egg still more fully from injury in being swallowed."

From the fact that the eggs cracked open with a snap when pressure was applied, and that many maggots escaped safely, it occurred that possibly the normal method of hatching for these eggs is by the pressure of the mandibles of the caterpillar in biting the leaves on which the eggs have been laid. Accordingly, several caterpillars were killed immediately after they had eaten quite a number of eggs that had been placed close together on a bit of leaf, and in each case the little maggots were found to have already escaped from the eggs and were crawling about amongst the bits of leaf in the crop of the caterpillar. By the shells being cracked thus by the mandibles of the caterpillar, the young maggots escape immediately from the eggs and can proceed to bore thru the wall of the alimentary canal, before being carried away along with the frass.

From this, it seems to me, that the purpose of the thickened egg-shell is to protect the enclosed maggot from drying up too soon, if it should happen to remain on the leaf for any length of time before being eaten by a caterpillar; and secondly, that the egg may split open under the pressure of the caterpillar's mandibles, allowing the maggot to escape safely instead of being crushed in the egg, as it would be if the egg were soft.

KOEBELE'S ICHNEUMON.

Ichneumon koebelei n. sp.

Plate III, fig. 7.

♀, ferruginous; eyes, apical half of antennae, dot between antenna and eye, tips of mandibles, most of the sutures of thorax, petiole beneath, and a narrow band at base of second and third abdominal segments, black; wings somewhat infuscated, stigma yellowish. Head and thorax finely punctured and clothed with fine pubescence. Scutellum very feebly punctured, shining, broader in front, a carina extending from each anterior angle along side of scutum; postscutellum narrow, transverse, shining, separated from scutellum by a furrow. Areae of metathorax well defined, punctate, sides longitudinally striate. Postpetiole broad, finely longitudinally striate. Second and third abdominal segments fine-

ly and densely punctured on dorsum, 2nd segment with short longitudinal striae at base, remaining segments smooth and shining. Abdomen pubescent below. Antennae stout. Length 14 mm.

♂, less ferruginous than ♀; face, scape of antennae, tegulae, scutellum, and anterior tibiae and tarsi yellowish; eyes, antennae except scape. a spot behind antennae. another including ocelli (sometimes these are united), sutures of thorax broadly, petiole below, broad band at base of second, third, fourth and fifth abdominal segments, black; apex of hind, tibiae blackish. More pubescent than female. Length 16 mm.

This valuable parasite was introduced from America by Mr. Koebele several years ago. The date of introduction is not known; but after becoming established the first record of its appearance is a specimen taken by Dr. Perkins, in June, 1900. Since then it has become generally spread, and quite common locally, usually the most observed where there is an abundance of army worms and cutworms. During 1905-1907, I saw them quite abundant at several places on Hawaii, Maui and Oahu; but so far, I know of no records of its occurrence on Kauai or Molokai. It was especially introduced to prey upon army worms and cutworms, and I do not know of it attacking any other kind of caterpillar.

Little is known of its life history, further than that the female parasite deposits her egg inside a living caterpillar; the larva there lives upon the fluids and fat, not causing the death of its host until after the latter has pupated; then the parasite completes its growth and becomes a pupa within the host pupa, and in due time the adult parasite emerges therefrom.

Specimens were submitted to Dr. Howard of the Bureau of Entomology, Washington, for identification. He has kindly compared them with specimens in the U. S. National Museum, and found that it is not contained there. He writes further regarding it: "I then sent it to Mr. Viereck, who compared it with the Philadelphia collection, and while, he says, it comes near to *Ichneumon brevipennis,* it is evidently distinct from that species." Hence, it is apparently an undescribed species, and I have herewith described it, naming it for Mr. Koebele, who has done so much valuable work for economic entomology in Hawaii.

PLATE I.

Cane shoot badly eaten by army worms.

BULLETIN No. 7

~~CIRCULAR No. 5~~

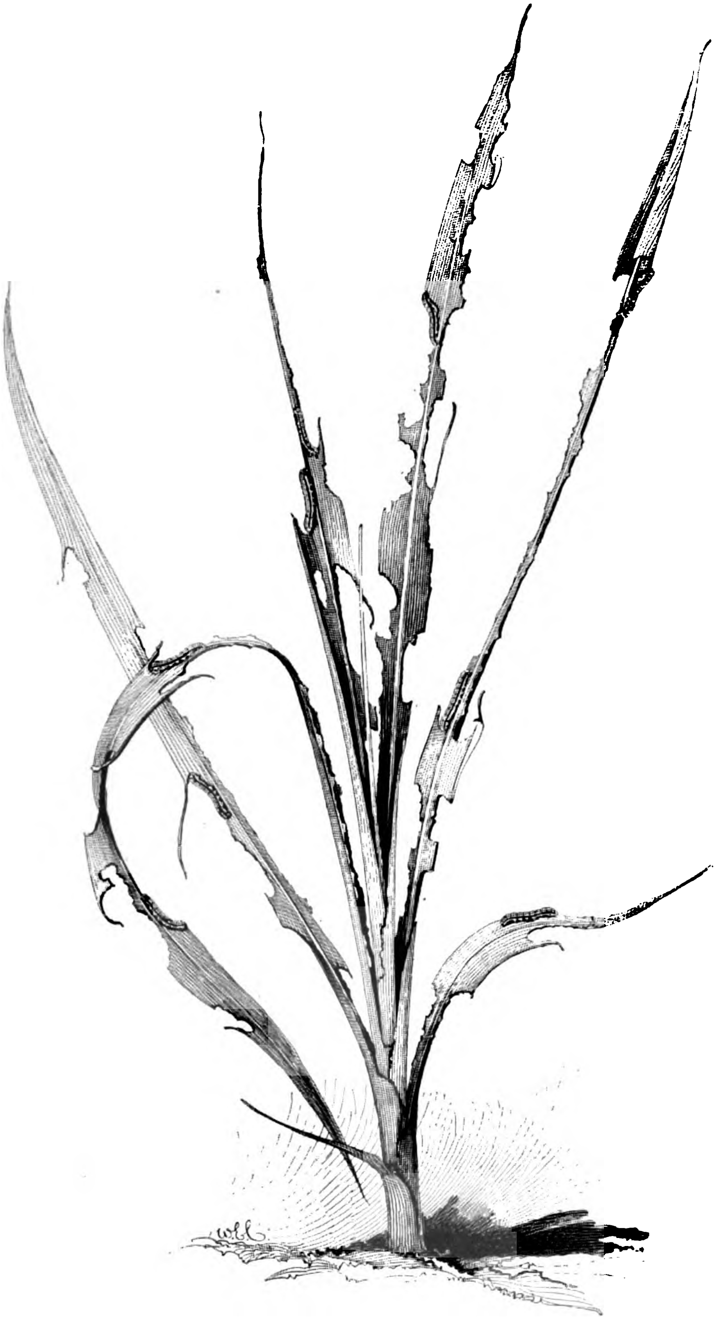

PLATE I.

Plate II.

1 *Agrotis ypsilon,* male.
2 " " caterpillar; p. prolegs, s. spiracles, t. tubercles.
3 *Feltia dislocata,* male.
4 " " caterpillar.
5 " " cluster of eggs.
6 " " egg highly enlarged.
7 *Spodoptera mauritia,* male.
8, 9 " " caterpillar, (two color varieties).
10 " " cluster of eggs.
11 " " egg highly enlarged.
12 *Agrotis crinigera,* male.
13 " " caterpillar.

BULLETIN No. 7

~~CIRCULAR No. 5.~~

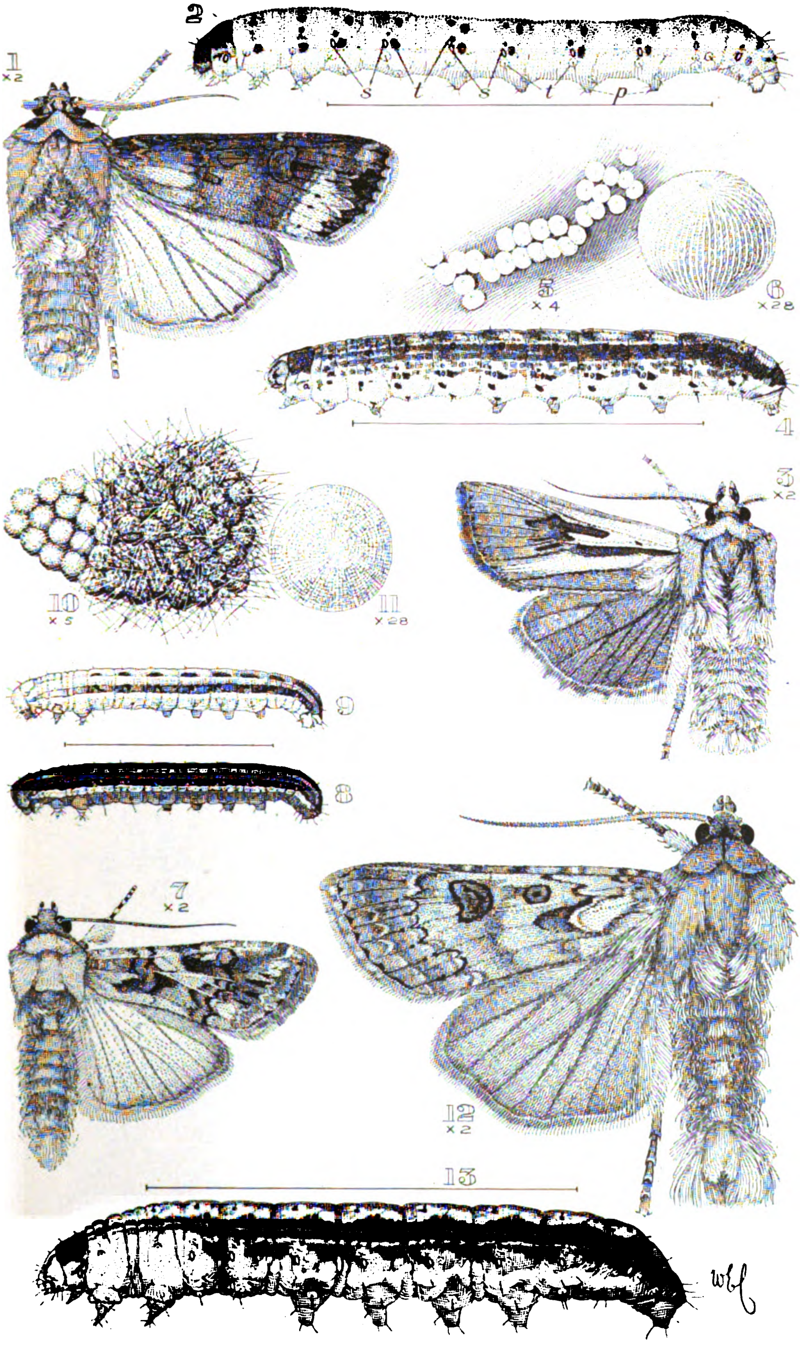

PLATE II.

Plate III.

1 *Lycophotia margaritosa,* male.
2 " " caterpillar.
3 *Cirphis unipuncta,* male.
4 " " caterpillar.
5 " " pupa.
6 " " apex of pupa highly enlarged.
7 *Ichneumon koebelei,* female.
8 *Chaetogaedia monticola.*
9 " " larva.
10 " " puparium.
11 " " posterior segment of puparium highly enlarged.
12 " " egg on grass leaf, enlarged.
13 " " egg highly enlarged.

BULLETIN No. 7

~~CIRCULAR No. 5.~~

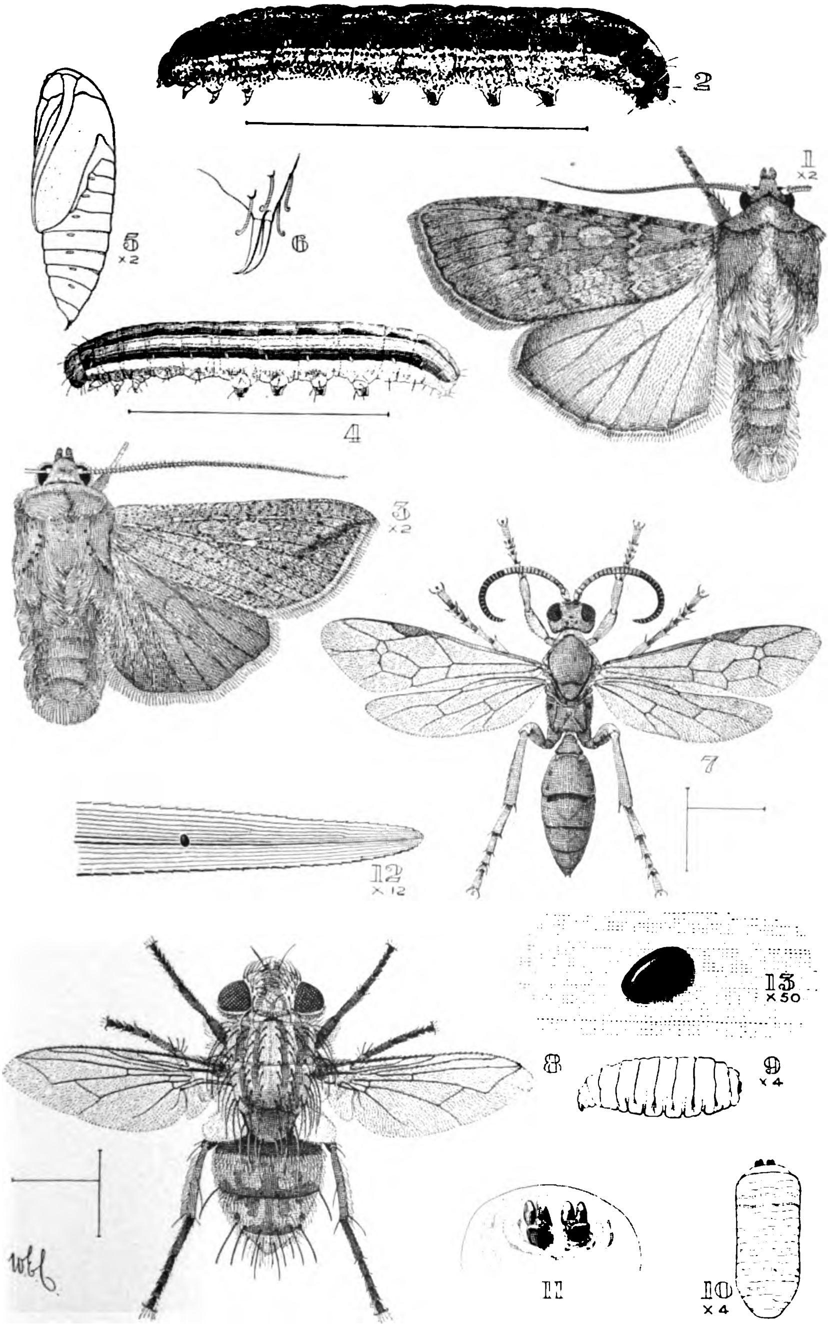

PLATE III.

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

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	Assistant Chemist
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L. D. LARSEN	Assistant Pathologist
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G. H. TUTTLE	Cashier
W. R. R. POTTER	Illustrator
A. WARREN	Clerk
J. F. MELANPHY	Fertilizer Sampler

DIVISION OF ENTOMOLOGY
BULLETIN No. 8

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

A Bibliography of Sugar-Cane Entomology

By G. W. KIRKALDY

HONOLULU, HAWAII
DECEMBER, 1909

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the
Hawaiian Sugar Planters' Association,
Honolulu, Hawaii.

Gentlemen:—I herewith submit Bulletin VIII of the Division of Entomology. It has been prepared by myself, and is entitled "A Bibliography of Sugar Cane Entomology."

Yours obediently,

G. W. KIRKALDY,
Acting Director, Division of Entomology.

Honolulu, Hawaii,
September 1, 1909.

This bibliography is intended primarily as a work of reference for the Entomologists of the Hawaiian Sugar Planters' Association.

It is probable that some references have been overlooked, though it is not likely that these are of special value; on the other hand, a considerable number of apparently worthless notes have been included, because it is impossible, beforehand, to draw any line between them and those which will prove important locally.

The bulletin is divided into two parts.

(a) A list of works, arranged under authors;

(b) A preliminary list of the insects, spiders, etc., of the sugar cane fields.

† indicates that the work has not been accessible.

* * indicates that the work is private and has been distributed only to the members of the Hawaiian Sugar Planters' Association.

[. . .] means that there is no special title to the paper, or that I have not seen it.

* (in part 2) indicates a Hawaiian species.

As the bulletin is merely a working list and not intended to serve as a complete bibliography, many of the titles are abbreviated, the lacunae being shown by " . . . . " In the precis, the original name is usually given.

The numbers, after the author's names in the second part, refer to part 1.

PART I.

A LIST OF AUTHORS.

ALCOCK, A.:

1. " . . . . Pests of the Sugar Cane," Ind. Mus. Notes V. 40-4 (1900).

AVEQUIN, J. B.:

1. [Enemies of Sugar Cane in Antilles and Louisiana], Journal Pharmacie, XXXII. 335-7 (1857).
   Cf. Ins. Life IV. 96 (1891 Nov.)
   Diatraea saccharalis and Calandra

BANCROFT, J.:

1. † Second Ann. Rep. of Board appointed to enquire in the causes of Diseases affecting live stock and plants, &c." (Brisbane 1877) pp. 12-13, figs.
2. † Diseases of animals and plants that interfere with Colonial Progress" (Brisbane 1879), pp. 8-9.
3. † "Rep. of the Board appointed to enquire into the causes of diseases affecting live stock and plants" (Brisbane 1876) pp. 19-31, 2 Pls.

BALLOU, H. A.:

1. "Review of Insect Pests Affecting the Sugar Cane," West Ind. Bull. V. 37-47 (1905).
   Reprint Haw. Pl. Mo. XXIV. 267-74 (1905 June 15).
   Diatraea saccharalis; Ligyrus tumulosus; Sphenophorus sericeus; Diaprepes abbreviatus; Delphax saccharivora; Xyleborus perforans; Castnia licus; Coccidae; and Parasites.

BARLOW, E.:

1. "Miscellaneous Notes from the Entomological Section," Ind. Mus. Notes IV. 35-6 (1896).
   Aspidiotus; Termes taprobanes.

BARRETT, O. W.:

1. "The Changa or Mole Cricket (*Scapteriscus didactylus* Latr.) in Porto Rico," Bull. Porto Rico Agr. Station, II. 1-9, fig. 1 (1902).
   [Reprint Haw. Pl. Mo. XXIII. 222-37, fig. 1 (194)].

DE BARRY:

1. † "Mémoires sur les Fourmis de Canne à Sucre," (Paris) pp. 1-18 (1785).
2. † "Le Bréton's Traité sur les Propriétés et les Effects du Sucre" (Paris) pp. 157-84 (1789).

BECKFORD ,W.:

1. † "Descriptive Account of the Island of Jamaica," II. 52-4 (1790).
   Diatraea saccharalis.

BLANDFORD, W. F. H.:

1. "Notes on Scolytidae and their Food-Plants," Ins. Life, VI. 260-5 (1894 Feb.).
   Xyleborus perforans; Hypothnemus eruditus.
2. "The Identity of *Xyleborus affinis,*" Ent. News. IX. 3-6 (1898, Jan.).

BOJER, W.:

1. † "Report of the Select Committee Appointed to Examine the Extent of the Damage Done by the Cane Borer in Mauritius," pp. 1-21, Pls. I-V (1856).
   Diatraea saccharalis [as Proceras sacchariphagus]
   [Reprint in Sugar Cane, V. 477-83, (1873, Sept.) and 534-7 (Oct. 1), 3 Pls.].

BERG:

1. † [*Pulvinaria iceryi*], Soc.d'Acclim. IX. 939 (1862).

BORDAGE, E.:

1. † "Sur deux Lepidopterés Nuisibles à la Canne à Sucre aux Iles Mascareignes," C. R. Ac. Sci France, 1109-1112 (1897).
   Diatraea saccharalis; Sesamia nonagrioides.
2. † [Ichneumonid parasites of the Sugar Cane Borer in the Island of Réunion]. [source?]
   Ophion mauritii and antankarus on Diatraea striatalis and Sesamia albiciliata.
   [Résumé Bull. U. S. Ent. XXX. 82, fig. 29 (1901)].

BOS, H.:

1. † "Een vijand van het Suikerriet, *Apogonia destructor* nov. spec.", Tijdschr. Ent. XXXIII. 311-48, 2 Pl. (1890).

BREDDIN, G.:

1. "Javanische Zuckerrohrschädlinge aus der Familie der Rhynchoten," Deutsche Ent. Zeitschr. XL. 105-10 (1896, May).

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   Prt. 8, Bull. H. S. P. Ent. I. 239-67, Pls. 18-20, Hymenoptera, 1906 Jan.;
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* This bulletin (including Parts 5, 7, and 9 by Terry, Swezey, and Kirkaldy, q. v.) has been reviewed, partly or entirely, in (among others):

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1. "Insect Pests of the Sugar Cane in India," Ind. Mus. Notes, V. 64-91.
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2. "Life History Notes, and Observations on Three Common Moths," P. H. E. S. I. 53-8, (1906 Dec.).
57 Spodoptera mauritia on cane.
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3. "New Cane Varieties and New Diseases," Haw. Pl. Mo. Mo. XIV, 449-59, (1895 Oct.).
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2. † "Report of the Committee, etc., for Investigating the the Nature of the Ravages of the Cane Fly, Delphax saccharivora in Grenada," (London) pp. 1-2. (183).
3. "Introduction to the Modern Classification of Insects," Vol. I. 347-8, (1838-1840).
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   477-97 Diatraea saccharalis; Diatraea striatalis 477-97, Pl. 5, Fig. 1-8, figs. 12-15; Ceraphron beneficiens 487-90, Pl. 60, Figs. 16-24; Chaetosticha nana 490-5 Pl. 5, Figs. 9-11.
4. "De bladboorders van het Suikerriet of Java," Arch. Java Suik. IV. 793-804, Pl. 17, (1896).
   793-801 Hispella wakkeri, Pl. I, Figs. 1-12; 799 Eulophus femoralis Figs. 13-16; 801 Aphanisticus krügeri; Cosmopteryx sp.; Phytomyza sp.
5. [Wåwålankevers in den Oostmoesson], Arch. Java Suik. IV. 808-9. (1896).
6. "De Bestrijding der boorders," Handl. eerste Congres Alg. Synd. Suikerfabrik. Java, 110-5 (1896).
7. "De plantenluizen van het Suikkerriet of Java," Arch. Java Suiker. IV. 937-50, Pl. 20 (1896 Oct. 1).
   [Reprinted as Med. Oost Java n. s. No. 29].
   939 Aleurodes bergi, Pl. 20, figs. 1-16; 947 Prospalta tristis, Pl. 20, figs. 17-21.

8. "De plantenluizen van het Suikerriet of Java," Arch. Java Suik. V. 193-218, Pls. 3-4 (1897 Feb. 15).
[Reprinted as Med. Oost Java No. 36].
193-212 Chionaspis sacchariifolii, Pl. III, Figs. 1-17 (& 3 text figs.) and Pl. 4, Figs. 20-29; 211-212 Aphelinus simplex, Pl. III, Figs. 18-19; Chionaspis depressa Pl. IV, Figs. 30-39.

9. "De Kentjong-Kever," Arch. Java Suik. V. 23-4 (1897).

11. "Voorloopige mededeelingen over een Luizerplaag," Arch. V. 381-5. (1897).
Aleurodes longicornis.

12. "Verspreiding van Boorders," Arch. Java. Suik. 486-93. (1897).

13. "Overzicht van de Ziekten van het Suikerriet op Java II." Arch. Java. Suik. V. 525-75. (1897).
[Reprinted as Med. Ooost Java No. 37].
Coleoptera 529-36; Lepidoptera 536-45; Diptera 545-7; Hemiptera 547-64; Orthoptera 564-8; Neuroptera 568-9; Thysanura 569-72; Acari 572-3.

14. De plentenluizen van het Suikerriet op Java IV," Arch. Java Suik. V. 735-44, Pl. 8. (1897).
[Reprinted as Med. Oost Java No. 39].
735 Aspidiotus saccharicaulis, Pl. 8 1 text figure.

15. "Praktische Wenken voor Entomologische Werkzaamheden op Suikerondernemingen," Arch. Java Suik. V. 783-807, Pl. 9. (1897).
[Reprinted as Med. Oost Java No. 40].
Instructions for collecting, setting, etc.

16. "De Mineerlarven van het Suikerriet op Java II-III," Arch. Java. Suik. V. 979-992, Pl. (1897).
[Reprinted as Med. Oost Java No. 42].
Aphanisticus spp., Pl. 9, Figs. 1-15; Closterocerus tricinctus

17. "*Heteronychus sp?* I. De Kentjong-Kever," Arch. Java. Suik. VI. 337-42, Pls. 8, Fig. 1-14. (1898).

"II. Verdere Waarnemingen omtrent den Wåwålan. (*Apogonia destructor* H. Bos)" 343-60. Pl. 8. Fig. 15.
Paras. 249-54 Botrytis; 354-9 Masicera, Pl. 8. Figs. 16-19.
[Reprinted as Med. Oost Java No. 47].

18. "Shotborer," Arch. Java Suik. VI. 586-7. (1898).

19. "Levenswijze en bestrijdning der boorders V.," Arch. Java Suik. VI. 673-82, Pl. 12. (1898).

[Reprinted as Med. Oost Java (3) III and Med. West Java No. 34].

673-9 Sesamia nonagrioides var. albiciliata, Pl. 12, figs. 1-11; 679-81 Bandongboorder, Pl. 12, Figs. 12-15.

20. "De Mineerlarven van het Suikerriet op Java IV," Arch. Java Suik. VI. 793-807, Pl. 13. (1898).

Cosmopteryx pallisfasciella; Chalcis; Bracon; Pleurotropis thoracica; Derostenus albipes; Closterocerus.

[Reprinted as Med. Oost Java (3) IV].

21. "De plantenluizen van het Suikerriet of Java V-VI," Arch. Java Suik. VI. 1085-98, Pl. 14. (1898).

1085-90 Chionaspis madiunensis, Pl. 14, figs. 1-9; 1089 Physcus flavidus figs. 11-16; 1090-3 Chionaspis tegalensis, figs. 17-20; 1094-7 Chionaspis sp.; fig. 10, egg of Chionaspis saccharifolii.

[Reprinted as Med. Oost Java No. (3) 6, and Med. West Java No. 37].

22. "Over eenige insektenplagen bij de Rietkultuur op Java," Handl. tweede Congres Alg. Synd. Suikerfabrik. Java 247-65. (1898).

23. "De Plantenluizen van het Suikerriet op Java VIII," Arch. Java Suiker. VII. 445-65, Pls. I and II (1899 April 1).

445-59 Aleurodes longicornis Pl. I; and 459-64 lactea. Pl. 2, figs. 15-17, and 462 Encarsia (Hym), Pl. 2, figs. 18-19.

[Reprinted as Med. West. Java No. 38].

24. "Wilde Voederplanten en Verspreiding der Boorders," Arch. Java Suik. VII. 1012-16. (1899).

25. "De riet Schorskever, *Xyleborus perforans* Wollaston," Arch. Java Suik. VIII. 501-21. Pl. 6. (1900).

[Reprinted as Med. West Java No. 44].

26. "Nieuwe parasiten der boorders," Arch. Java Suik. VIII. 773-85. Pl. 7. (1900).

733 Elasmus, Pl. 7, Figs. 1-4; 449 Braconid Figs. 10-12; 776 Macrocentrus. Figs. 5-8; 781 Braconid, Figs. 13-14.

[Reprinted as Med. West Java No. 46].

27. "De Plantenluizen van het Suikerriet op Java X," Arch. Java Suik. VII. 1013-44, Pls. 8-9. (1900).

[Reprinted as Med. West Java 49].

1013 Ceratovacuna lanigera, Pl. 8 figs. 1-4, and Pl. 8, figs. 17-18; 1024 Encarsia? flavoscutellum figs. Pl. 8. 5-6 and Pl. 9. figs. 17-18; 1025 Chrysopa sp. 1, Pl. 9, fig. 34; 1030 Osmylus sp. Pl. 8, figs. 7-10; 1032 Pteromalid gen. and sp? figs. 11-13;

1033 Coccinellid sp? Pl. 9, figs. 19-23; 1036 Ephestia cautella Pl. 8, figs 14-16; 1038 Tetrastichus, Pl. 9, figs. 26-27; 1040 Halticella, Pl. 9, figs. 24-25.

28. "De Mijten van het Suikerriet op Java I," Arch. Java Suik. IX, 193-209. Pls. 1-2.

[Reprinted as Med. West Java 51].

29. "De Plantenluizen van het Suikerriet op Java, XI and XII," Arch. Java Suiker. IX. 577-94, Pl. 7-8. 1901).

577-82 Aspidiotus, Pl. 7, figs. 1-13; 582-91 Planchonia Pl. 8; Hym. parasites. 591 Apheline? Pl. 7, figs. 16-18; Encyrtine, Pl. 7, figs. 14-15.

[Reprinted as Med. West. Java 52].

30. "De Planzenluizen van het Suikerriet op Java, XIII," Arch. Java Suiker. IX. 673-94, Pls. I and II. (1901).

673-86 Aphis sacchari Pl. 9, figs. 1-10 and 686-8; adusta, Pl. 10 figs. 25-8; 688 Tetraneura lucifuga Pl. 10 figs. 29-34; 681 Aphelinus mali, Pl. 10, fig. 21; 679 Encyrtine sp. figs. 22-24; 683 Syrphid, Pl. 10, figs. 17-20.

[Reprinted as Med. West Java No. 53].

31. "Methode der Boorderbestrijding," Ed. 3, Proef. Suik. West Java Pekalongan, pp. 1-27, Pls. I and II. (1901).

Diatraea, Scirpophaga. Chilo, Grapholitha.

PART II.

A LIST OF SUGAR CANE INSECTS, SPIDERS, ETC.

ORDER NEUROPTERA.

* *Anomalochrysa decepta* (Hemerobiidae).
Terry 2.
* *A. gayi.*
Terry 2.
* *A. raphidioides.*
Terry 2.
* *Chrysopa microphya* (Hemerobiidae).
Perkins 1; Swezey 4; Terry 2.
C. spp.
Deventer 4; Zehntner 27.
* *Nesomicromus vagus* (Hemerobiidae).
Perkins 1.
Osmylus sp. (Osmylidae).
Deventer 4; Zehntner 27.

ORDER ORTHOPTERA.

(Including Pseudoneuroptera).

Acheta bimaculata [*Liogryllus*] (Gryllidae).
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
Acrydium aeruginosum (Acrydiidae).
Deventer 4.
A. luteicorne.
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
A. roseum.
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
A. zehntneri.
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
* *Allacta notulata* [*Phyllodromia hieroglyphica*] (Blattidae)
Perkins 1.
* *Anisolabis annulipes* (Forficulidae).
Perkins 1; Terry 2.
Atractomorpha crenulata (Acrydiidae).
Deventer 4; Koningsberger 1; Krüger 3.

A. psittacina.
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
Atropos sp. (Psocoptera).
Roth 1.
* *Chelisoches morio* (Forficulidae).
Lucas 1; Perkins 1; Terry 2.
* *Conocephalus latifrons* [*Anisoptera; Xiphidium*]. (Locustidae).
Swezey 1.
* *C. varipennis.*
Eckart 1; Perkins 1; Swezey 1. 3.
Elimaea chloris (Locustidae).
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
Epacromia tamulus (Acrydiidae).
Deventer 4; Koningsberger 1; Krüger 3.
* *Gryllotalpa africana* (Gryllidae).
Deventer 4; Eckart 1; Koningsberger 1; Krüger 3; Zehntner 13.
G. didactyla, vide Scapteriscus.
Hieroglyphus furcifer (Acrydiidae).
Hadi 1; Lefroy 7.
* *Labia pygidiata* (Forficulidae).
Perkins 1; Terry 2.
* *L. sp.?*
Perkins 1; Terry 2.
* *Labidura sp.?* (Forficulidae).
Terry 2.
Liogryllus vide Acheta.
"Locusts."
Caldwell 1.
Mecopoda elongata (Locustidae).
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
Oedalus marmoratus (Acrydiidae).
Cotes 2; Deventer 4; Stebbing 1.
* *Oxya velox* (Acrydiidae).
Deventer 4; Eckart 1; Koningsberger 1; Krüger 3.
O. sp.?
Deventer 4.

Phaneroptera sp.? (Locustidae).
Deventer 4; Krüger 3.
Phyllodromia hieroglyphica, vide Alacta notulata.
Poecilocera hieroglyphica (Acrydiidae).
Cotes 2; Hadi 1; Stebbing 1.
* *Psocidae.*
Perkins 1.
Scapteriscus didactylus (Gryllidae).
Barrett 1; Johnstone 3; Kirby and Spence 1.
Sphingolabis taeniata (Forficulidae).
Koebele 4.
Termes gilvus (Isoptera).
Deventer 4; Krüger 3.
T. taprobanes.
Alcock 1; Barlow 1; Cotes 1, 2; Hadi 1; Lefroy 7; Peal 1; Stebbing 1.
T. spp.
Koningsberger 1; Zehntner 13.
* *Tenodera sinensis* (Mantidae).
Kirkaldy 17.
Trilophidia annulata (Acrydiidae).
Deventer 4; Koningsberger 1; Krüger 3.
T. cristella.
Deventer 4; Koningsberger 1; Krüger 3.
Truxalis spp. (Acrydiidae).
Deventer 4.
Xiphidion and *Xiphidium,* vide Conocephalus.
X. *fuscum,* vide Conocephalus varipennis.

ORDER THYSANOPTERA.

Heliothrips striatoptera.
Deventer 4; Koningsberger 1; Krüger 3.
Oxythrips binervis.
Deventer 4; Koningsberger 1; Krüger 3.
Parthenothrips kobusi.
Deventer 4.
Phloeothrips amphicincta.
Krüger 3; Zehntner 13.

P. lucasseni.
Deventer 4; Koningsberger 1; Krüger 1, 3.
Physopus sexnotatus.
Deventer 4; Koningsberger 1; Krüger 3; Zehntner 13.
Stenothrips zehntneri.
Deventer 4.
Thrips minuta.
Deventer 4.
T. sacchari.
Deventer 4; Koningsberger 1; Krüger 1, 3.
T. serrata.
Deventer 4; Koningsberger 1; Kobus.

ORDER HEMIPTERA.

Agonoscelis nubilis (Cimicidae).
Nicéville 2.
Aleyrodidae (general).
Kirkaldy 8; Peal 1.
Aleyrodes barodensis (Aleyrodidae).
Lefroy 7; Maskell 2, 6; Peal 2; Stebbing 1.
A. bergi [=*berghii*].
Guérin 1; Kirkaldy 4; Koningsberger 1; Krüger 3; Muir 1; Signoret 1; Zehntner 7, 13.
A. lacteus [= — *tea*].
Koningsberger 1; Krüger 3; Zehntner 13, 23.
A. longicornis.
Koningsberger 1; Krüger 3; Zehntner 11, 13, 23.
A. sacchari.
Kirkaldy 4; Maskell 1.
Anthocoris pacificus (Anthocoridae).
Kirkaldy 4.
Antonina sp? [= *Planchonia sp*]. (Coccidae).
Koningsberger 1; Zehntner 1, 3, 29.
Aphidae (general).
Browne 1; Kirby and Spence 1; Morris 1; Went 1; Zehntner 11.
Aphis vide Loxerates.
Aspidiotus glomeratus, vide Targionia.

A. sacchari. (Coccidae).
Cockerell 2 &c.; Lefroy 8; Leonardi 1.

A. sacchari caulis, vide Odonaspis.

A. spp.
Barlow 1; Zehntner 29.

Astorga saccharicida (Fulgoridae).
Kirkaldy 2.

Belus, vide Zelus.

Blissus gibbus (Myodochidae).
Alcock 1; Distant 2; Hadi 1; Peal 1; Stebbing 1.

B. leucopterus.
Koebele 4.

Brachyplatys pacifica (Cimicidae).
Kirkaldy 4.

Ceratovacuna, vide Oregma.

Cicadula euryphaessa (Tetigoniidae).
Kirkaldy 3, 4.

Chionaspis depressa (Coccidae).
Koningsberger 1; Krüger 3; Zehntner 8, 13.

C. madiunensis.
Zehntner 21.

C. saccharifolii.
Koningsberger 1; Krüger 3; Zehntner 8, 13, 21.

C. tegalensis.
Zehntner 21.

C. sp.
Kotinsky 2.

Coccidae (General).
Ballou 1; Fernald 1; Hooker 1; Lefroy 5; Signoret 2.

Coccus sacchari, vide Icerya seychellarum.

C. sinensis (Coccidae).
Walker 1.

Colobathristes, vide Phaenacantha.

Conorhinus, vide Triatoma.

Cyrtodisca major (Tetigoniidae).
Koebele 4.

C. sp.
Koebele 4.

Cyrtorhinus mundulus (Miridae).
Breddin 1; Deventer 4; Kirkaldy 4; Koningsberger 1; Krüger 3; Zehntner 13.
Dactylopius, vide Trechocorys.
Dicranotropis vastatrix, vide Perkinsiella.
Dictyophora pallida, vide Pyrilla aberrans.*
Diplorhinus furcatus (Cimicidae).
Ellenrieder 1.
Eosaccharissa javana (Fulgoridae).
Kirkaldy 5.
Eumetopina krügeri (Asiracidae).
Breddin 1; Deventer 4; Koningsberger 1; Krüger 3; Perkins 1; Zehntner 13.
* *Fulvius peregrinator* (Miridae).
Kirkaldy 11.
Heronax saccharivora (Derbidae).
Kirkaldy 2.
Icerya seychellarum [=*Dorthesia seychellarum* = *Coccus sacchari, &c.*], (Coccidae).
Charmoy 1; Coquillett 1; Delteil 1; Guérin 1; Hartmann 1; Howard 6; Krüger 3; Maskell 5; Riley and Howard; Roth 1; Signoret 1, 2; Westwood 3a.
"Lecanium" guerinii (Coccidae).
Guérin 1; Signoret 1.
L. iceryi, vide Pulvinaria.
"L." krügeri.
Koningsberger 1; Krüger 3; Zehntner 13.
Loxerates adusta (Aphidae).
Köningsberger 1; Krüger 3; Zehntner 13, 30.
* *L. sacchari.*
Eckart 1; Kirkaldy 7; Köningsberger 1; Krüger 3; Perkins 9; Zehntner 13, 20.
Nesosteles hebe (Tetigoniidae).
Kirkaldy 4.
Ninus stylatus (Myodochidae).
Kirkaldy 4.

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* According to Distant, the true *Dictyophora pallida* is found on Sugar Cane.

Odonaspis secreta, var. *saccharicaulis* [*Aspidiotus*] (Coccidae).
Köningsberger 1; Krüger 3; Zehntner 10, 13, 14.

* *Oechalia grisea* (Cimicidae).
Kirkaldy 12, 14; Perkins 1; Swezey 1, 3.

* *O. kaonohi.*
Kirkaldy 4.

Oliarus saccharicola (Fulgoridae).
Kirkaldy 3, 4.

Oregma lanigera [*Ceratovacuna*] (Aphidae).
Köningsberger 1; Krüger 3; Zehntner 13, 27, 30.

* *Peregrinus maidis* (Asiracidae).
Eckart 1; Kirkaldy 2, 5, 6.

Periscopus, vide Cyrtorhinus.

Perkinsiella pseudomaidis (Asiracidae).
Kirkaldy 2, 4.

* *P. saccharicida.*
Craw 5; Eckart 1; Kirkaldy 1, 2, 3, 5; Muir 3; Perkins 1, 2, 9; Van Dine 1.

P. sinensis.
Kirkaldy 1.

P. vitiensis.
Kirkaldy 1.

P. vastatrix.
Deventer 4; Breddin 1; Köningsberger 1; Kirkaldy 2, 5; Krüger 3; Muir 4, 5; Perkins 1, 9; Zehntner 13.

P. spp.
Muir 2, 3.

Phaenacantha saccharicida [*Colobathristes*] (Myodochidae).
Breddin 1; Deventer 4; Karsch 1; Köningsberger 1; Krüger 3; Zehntner 13.

Planchonia, vide Antonina.

Phenice maculosa, vide Proutista moesta and P. lumholtzi.

* *Physopleurella mundula* (Anthocoridae).
Kirkaldy 15; Perkins 1; Swezey 1.

Proutista lumholtzi (Derbidae).
Kirkaldy 1.

P. moesta.
Deventer; Kirkaldy 1, 5; Köningsberger 1; Krüger 3; Muir 3; Perkins 1; Zehntner 13.

Pseudococcus, vide Trechocorys.

Pulvinaria iceryi [*Lecanium*] (Coccidae).
Berg 1; Guérin 1; Icery 1; Signoret 1, 2.

Pyrilla aberrans (Fulgoridae).
Kirkaldy 5, 6.

P. lycoides.
Distant.

P. perpusilla [= Dictyophora pallida].
Alcock 1; Kirkaldy 5, 6; Lefroy 7; Nicéville 2; Stebbing 1.

Pyrrhoneura saccharicida (Derbidae).
Kirkaldy 2, 4.

Ripersia sacchari (Coccidae).
Alcock 1; Green 1; Stebbing 1.

* *Reduviolus blackburni* (Nabidae).
Swezey 1.

* *R. capsiformis* [= *blackburni* = *innotatus*].
Kirkaldy 9, 13; Perkins 1; Swezey 1.

Saccharodite sanguinea (Derbidae).
Kirkaldy 5.

Saccharias deventeri (Derbidae).
Kirkaldy 5.

Saccharosydne saccharivora (Asiracidae).
Ballou 1; Johnstone 1, 2; Kirby and Spence 1; Kirkaldy 2; Krüger 3; Lefroy 3; Westwood 1, 2, 3.

Scaptocoris talpa (Thyreocoridae).
Champion 1.

Stenocranus pacificus (Asiracidae).
Kirkaldy 2, 4.

Targionia glomerata [*Aspidiotus*] (Coccidae).
Green 2.

Teleonemia sacchari (Tingididae).
Fabricius 2.

Tetranura lucifuga (Aphidae).
Köningsberger 1; Krüger 3; Zehntner 13, 30.

Tetigonia albidomarginata (Tetigoniidae).
Kirkaldy 3.

T. spectra [= *albida*].
Kirkaldy 2.

T. parthaon.
Kirkaldy 2.

Tomaspis [= *Thomaspis*!] sp. (Cercopidae).
Hart 1.

* *Trechocorys calceolariae* [*Dactylopius; Pseudococcus*]. (Coccidae).
Eckart 1; Köningsberger 1; Kirkaldy 15, 17; Lefroy 8; Maskell 1.

* *T. sacchari.*
Busck 1; Charmoy 1; Cockerell 3; Green 2; Kirkaldy; 17; Lefroy 8; Maskell 4; Perkins 9.

T. sp.
Zehntner 13.

* *Triatoma rubrofasciata* (Reduviidae).
Kirkaldy 15; Köningsberger 1.

* *Triphleps persequens* (Anthocoridae).
Swezey 1.

* *T. pumilio.*
Kirkaldy MS.

Tropidocephala saccharivorella (Asiracidae).
Matsumura 1.

Zamila, vide Pyrilla.

* *Zelus renardii* [= *peregrinus*] (Reduviidae).
Kirkaldy 9, 15; Perkins 1, 9; Swezey 1.

Halyomorpha guttula (Cimicidae).
Ellenrieder 1.

Nezara viridula (Cimicidae).
Ellenrieder 1.

Miscellanea.
Köningsberger 1; Zehntner 13,

ORDER COLEOPTERA.

* *Adoretus umbrosus* (Lamellicornia).
Deventer 4; Muir 3; Perkins 9.
A. sp.?
Deventer 4.
* *Aegosoma reflexa* (Longicornia).
Eckart 1; Krüger 3; Perkins 9; Terry 6.
* *Aeolus cinnamomeus* (Elateridae).
Perkins 1.
Anomala aerea (Lamellicornia).
Deventer 4.
* *A. atrovirens?*
Köningsberger 1.
A. sp.?
Deventer 4; Muir 3.
Anoplognathus lineatus (Lamellicornia).
Krüger 3.
Aphanisticus consanguineus (Buprestidae).
Deventer 4; Köningsberger 1; Krüger 3; Ritsema 1; Zehntner 13, 16.
A. krügeri.
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 4.
Aplosonyx elongatus (Chrysomelidae).
Stebbing.
Apogonia destructor (Lamellicornia).
Bos 1; Deventer 4; Kobus 3; Köningsberger 1; Krüger 3; Zehntner 5, 13, 17.
A. ritsemae.
Deventer 4; Köningsberger 1.
* *Aramigus fulleri* (Curculionidae).
Van Dine 2.
Archaioneda tricolor (Coccinellidae).
Muir.
Aulacophora sp. (Chrysomelidae).
Köningsberger 1.
Calandra palmarum, vide Rhynchophorus.
C. sacchari, vide Sphenophorus.
* *Callineda testudinaria* (Coccinellidae).
Swezey 1.

* *Carpophilus dimidiatus* and *maculatus* (Nitidulidae).
Perkins 1.

Chauliognathus pennsylvanicus (Malacodermidae).
Morgan 1.

Chilomeles sexmaculata (Coccinellidae).
Deventer 4.

Cleonus superciliosus (Curculionidae).
Köningsberger 1; Krüger 3.

* *Coccinella repanda* (Coccinellidae).
Perkins 1; Swezey 1, 4; Terry 6.

C. sanguinea.
Koebele 4.

Coccinellidae spp.
Deventer 4; Zehntner 27.

Coelophora inaequalis.

Collops quadrimaculatus (Malachiidae).
Swezey 1.

Copris sp? (Lamellicornia).
Deventer 4.

* *Cryptolaemus montrouzierii* (Coccinellidae).
Perkins 1; Swezey 4.

Diaprepes abbreviatus (Curculionidae).
Ballou 1; Watson 1.

Dinoderus minutus (Ptinidae).
Nicéville 2.

Elater noctilucus (Elateridae).
Kirby and Spence 1; Krüger 3; Say 1.

* *Elenchus tenuicornis* (Strepsiptera).
Muir 1, 2.

* *Eopenthes konae* (Elateridae).
Perkins 1.

Eutyrrhinus meditabundus (Curculionidae).
Krüger 3.

Halticella sp.? (Halticidae).
Zehntner 27.

Haplosonyx, vide Aplosonyx.

* *Haptoncus mundus* and *tetragonus* (Nitidulidae).
Eckart 1; Perkins 1, 9.

Heteronychus morator (Lamellicornia).
Deventer 4; Köningsberger 1; Krüger 3; Mulder 1; Zehntner 13, 17.

Hippodamia convergens (Coccinellidae).
Koebele 4.

Hexagonia kirbyi (Carabidae).
Köningsberger 1.

H. lucasseni.
Köningsberger 1.

Hispa sp.? (Chrysomelidae).
Deventer 4.

Hispella wakkeri (Chrysomelidae).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 4, 13.

H. sp.?
Deventer.

Holaniaria picescens (Tenebrionidae).
Deventer 3, 4; Köningsberger 1; Krüger 3.

Holotrichia leucophtalma (Lamellicornia).
Deventer 4.

* *Homalota sp.* (Carabidae).
Perkins 1.

Hoplosternus sp.? (Lamellicornia).
Köningsberger 1; Krüger 3; Roth 1.

Hypomeces unicolor (Curculionidae).
Deventer 4; Krüger 3; Zehntner 13.

* *Hypothenemus sp.* (Scolytidae).
Eckart 1; Perkins 8.

H. eruditus.
Blandford 1.

* *Itodacnus sp.* (Elateridae).
Perkins 1.

Laemotmetus ferrugineus (Cucujidae).
Stebbing 2.

Lepidiota albohirta (Scarabaidae).
Krüger 3.

L. squamulata.
Shelton 1; Tryon 2.

Leptispa pygmaea (Chrysomelidae).
Stebbing.

Ligyrus rugiceps (Lamellicornia).
Comstock 1; Howard 1; Kent 1; Krüger 3; Nicéville 2; Stubbs 1; Titus 1; Tryon 1.

L. tumulosus.
Ballou 1; Watson 1.

Megilla maculata (Coccinellidae).
Koebele 4.

M. vittigera.
Koebele 4.

Myllocerus isabellinus (Curculionidae).
Krüger 3.

Myochrous armatus (Chrysomelidae).
Theobald 1.

* *Neda abdominalis* (Coccinellidae).
Perkins 1.

Opatrum acutangulum (Tenebrionidae).
Deventer 4.

O. depressum.
Deventer 4.

* *Orcus ovalis* (Coccinellidae).
Perkins 4.

Oryctes rhinoceros (Lamellicornia).
Deventer 4; Muir 3; Zehntner 13.

* *Philonthus sp.* (Staphylinidae).
Perkins 1.

* *Platyomus lividigaster* (Coccinellidae).
Perkins 1.

* *Prosopus banksii* (Cerambycidae).
Terry 6.

Rhynchophorus ferrugineus (Curculionidae).
Krüger 3.

R. sp?
D'Urban 1.

R. palmarum
Avequin 1; Guilding 1; Kirby and Spence 1; Krüger 3; Ormerod 2, 3; Westwood 3.

Scymnus spp. (Coccinellidae).
Koebele 4.

* *S. vividus.*
Perkins 1; Swezey 4; Terry 6.

* *S. debilis.*
Kirkaldy 15.

Sitophilus oryzae (Curculionidae).
Stebbing 2.

* *Sphenophorus obscurus* (Curculionidae).
Eckart 1; Howard 4; Koebele 2, 3; Muir 3, 4; Perkins 9; Riley and Howard 1, 5; Smith 1; Terry 3, 4; Tryon 1, 3; Whitney 1.

S. ferrugineus.
Muir 3.

S. sacchari, vide sericeus.

S. sericeus.
Avequin 1; Ballou 1; Guilding 1; Kirby and Spence 1; Krüger 3; Lefroy 3, 4; Ormerod 2, 3; Watson 1; Westwood 3.

Synonycha grandis (Coccinellidae).
Deventer 4.

Tomarus bituberculatus (Cryptophagidae).
Ormerod 3.

* *Verania frenata* (Coccinellidae).
Swezey 1.

* *V. furcifera* [= sp.].
Swezey 1.

V. lineola, vide strigula.

* *V. strigula.*
Swezey 1.

Xyleborus affinis (Scolytidae).
Blandford 2.

X. perforans.
Ballou 1; Blandford 1; Cotes 2, 6; Deventer 4; Riley and Howard 3, 6; Köningsberger 1; Krüger 3; Urich 1; Zehntner 13, 18, 25.

X. piceus, vide pubescens.

X. pubescens.
Riley and Howard 2, 4.

X. sp.?
Stebbing 1.
Xylotrupes gideon (Lamellicornia).
Deventer 4; Krüger 3; Muir 3.

ORDER LEPIDOPTERA.

Acantholipes pansalis (Noctuidae). [also Dragana].
Cotes 1, 2; Stebbing.
Achaea melicerte (Noctuidae). [also Ophiusa].
Cotes 2; Stebbing.
Acidalia sp. (Geometridae).
Deventer 4.
Agrotis interjectionis, vide Euxoa.
A. sp.? (Noctuidae).
Koebele 4.
A. dislocata, vide Feltia.
* *A. crinigera.*
Swezey 6.
A. saucia, vide Lycophotia.
* *A. ypsilon.*
Swezey 6.
Anerastia ablutella (Pyralidae).
Lefroy 7.
Anticyra, vide Dinara.
Aroa socrus (Bombycidae).
Deventer 4.
Automeris sp. (Saturniidae).
Koebele 4.
* *Austosticha pelodes* (Gelechiidae).
Swezey 8, 9.
* *Batrachetra rileyi* (Elachistidae).
Swezey 8, 9.
Borer saccharellus, vide Diatraea saccharalis.
Borers (General).
Zehntner 12; Kobus 4.
Botys coclesalis, vide Pyrausta.
Castnia licus (Castniidae).
Ballou 1; Marchal 2; Marlatt 1; Urich 2.

Chilo auricilia (Pyralidae).
Lefroy 7.
C. infuscatellus.
Deventer 4; Köningsberger 1; Krüger 1, 3; Tryon 1; Zehntner 13.
C. simplex [also as *saccharalis*].
Alcock 1; Cotes 1, 2, 3, 4; Guénée 1; Krüger 1; Lefroy 6, 7; Nicéville 1, 2; Peal 1; Stebbing 1.
Chilo, see also Diatraea.
* *Cirphis unipuncta* [= *saccharivora*] (Noctuidae).
Butler 1; Cook 1; Deventer 4; Köningsberger 1; Krüger 3; Swezey 6.
C. loreyi.
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 13.
Cnaphalocrocis bifurcalis (Pyralidae).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 13.
C. medinalis [= *jolinalis*].
Deventer 4; Krüger 3.
Cosmopteryx pallifasciella (Elachistidae).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 4, 13, 20.
Creatonotus gangis [*Phissama*] (Bombycidae).
Deventer 4; Köningsberger 1; Krüger 3.
* *Cryptoblabes aliena* (Phycitidae).
Swezey 8, 9.
Cyllo leda (Rhopalocera).
Deventer 4; Kobus 6; Köningsberger 1; Krüger 3; Zehntner 13.
* *"Dancing Moth"* (Tineidae).
Swezey 8, 9.
Deiopeia, vide Utetheisa.
Diatraea saccharalis ‡ (Pyralidae).
Avequin 1; Ballou 1; Beckford 1; Bojer 1; Bordage 1; Buick 1; Cockerell 1; Comstock 1, 2; Cook 1; D'Urban 1; Fabricius 1; Guilding 1; Hamilton 1; Hein 1; Howard 2; Hughes 1; Kirby and Spence 1; Koebele 4; Lefroy 1, 2, 3; Mackenzie 1; Morgan 1;

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‡ = *Phalaena saccharalis* = *Chilo saccharalis* = *Proceras sacchariphagus* and *saccharifagus* = *Borer saccharellus.*

Morton 1; Ormerod 1, 2, 3; Porter 1; Riley 1; Riley and Howard 6; Stubbs 1; Stubbs and Morgan 1; Thompson 1; Westwood 4, 5.

D. striatalis.
Deventer 4; Hadi 1; Kobus 1; Kolk 1; Köningsberger 1; Krüger 2, 3; Roth 1; Snellen 2; Tryon 1; Yamasaki 1; Zehntner 3, 13, 31.

Dinara combusta [*Anticyra* and *Phalera*] (Bombycidae).
Deventer 4; Kobus 6; Köningsberger 1; Krüger 3.

Discophora celinde (Rhopalocera).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 3, 13.

Dragana pansalis vide Acantholipes.

Dreata petola (Bombycidae).
Deventer 4; Köningsberger 1; Krüger 3.

Ephestia cautella (Phycitidae).
Köningsberger 1; Zehntner 27.

Erechthias sp. (Erechthiadidae).
Krüger 3; Zehntner 13.

* *Ereunetis flavistriata* (Tineidae).
Swezey 8, 9.

* *E. minuscula.*
Swezey 8, 9.

E. pilosata.
Swezey 9.

E. muiriella.
Swezey 9.

· *Euproctis flavata* (Bombycidae).
Deventer 4.

E. minor.
Deventer 4; Köningsberger 1; Krüger 3.

Euxoa interjectionis [*Agrotis*] (Noctuidae).
Deventer 4.

* *Feltia dislocata* (*Agrotis*) (Noctuidae).
Swezey 9.

Grapholitha schistaceana (Tortricidae).
Deventer 4; Köningsberger 1; Krüger 1, 3; Tryon 1; Zehntner 13.

Halisidota sp. (Bombycidae).
Koebele 4.
Hesperia conjuncta (Hesperiidae).
Deventer 1, 4; Köningsberger 1; Krüger 3.
H. mathias.
Deventer 1, 4; Köningsberger 1; Krüger 3.
H. philino.
Deventer 1, 4; Kröningsberger 1; Krüger 3.
Heliophila unipuncta, vide Cirphis.
Laelia subrufa (Bombycidae).
Deventer 4; Köningsberger 1; Krüger 3.
L. adara [*Procodeca*].
Deventer 4; Köningsberger 1; Krüger 3.
Laphygma frugiperda (Noctuidae).
Krüger 3; Stubbs 1.
Leucania loreyi, vide Cirphis.
L. saccharivora, vide Cirphis unipuncta.
Leucophlebia lineata (Sphingidae).
Deventer 4; Köningsberger 1; Krüger 3.
* *Lycophotia saucia* (*Agrotis*) (Noctuidae).
Swezey 6.
Mancipium nepalensis (Rhopalocera).
Cotes 2; Stebbing 1.
Mycalesis mineus (Rhopalocera).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 13.
"Noctua gossypii" (Noctuidae).
Fabricius 1.
Nonagria exitiosa (Noctuidae).
Krüger 3.
N. inferens.
Nicéville 2.
N. uniformis.
Lefroy 7.
* *Omiodes accepta* (Pyralidae).
Eckart 1; Koebele 3; Perkins 9; Swezey 3.
* *O. continuatalis.*
Swezey 3.
* *O. epicentra.*
Eckart 1; Perkins 9.

Ophiusa melicerta vide Achaea.
* *Opogona aurisquamosa* (Tineidae).
Swezey 8, 9; Walsingham 1.
* *O. apicalis.*
Swezey 8, 9.
O. dimidiatella.
Köningsberger 1; Krüger 3; Zehntner 13.
O. fumiceps.
Swezey 9.
O. subcervinella.
Walsingham 1.
O. saccharella.
Swezey 8, 9.
Pamphila augias (Hesperiidae).
Deventer 1, 4; Köningsberger 1; Krüger 3; Zehntner 13.
P. dara.
Deventer 4; Krüger 3.
Phalaena saccharalis, vide Diatraea.
Phalera combusta, vide Dinara.
Phissama interrupta, vide Creatonotus gangis.
Polyocha saccharella (Pyralidae).
Lefroy 7.
Proceras sacchariphagus, vide Diatraea saccharalis.
Procodera adara, vide Laelia.
Psalis securis (Bombycidae).
Deventer 4; Kobus 6; Köningsberger 1; Krüger 3.
Pyrausta coclesalis [*Botys*] (Pyralidae).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 13.
Remigia frugalis (Noctuidae).
Deventer 4; Köningsberger 1; Krüger 3.
Scirpophaga auriflua [= *intacta*] (Pyralidae).
Alcock 1; Lefroy 7; Nicéville 2; Peal 1; Stebbing 1; Deventer 4; Krüger 1, 3; Tryon 1; Zehntner 13.
S. chrysorrhoa.
Krüger 3.
S. excerptalis.
Alcock 1; Peal 1; Stebbing 1.
S. monostigma.
Krüger 3.

Sesamia nonagriodes (Noctuidae).
Bordage 1, 2; Deventer 4; Howard 7; Krüger 2; Zehntner 19.
S. albiciliata vide nonagrioides.
Sphinx labruscae (Sphingidae).
Deventer 4; Krüger 3; Guilding 1.
* *Spodoptera mauritia* (Noctuidae).
Deventer 4; Eckart 1; Perkins 9; Swezey 2, 6.
S. pecten.
Deventer 4.
"Tortrix saccharifaga" (Torticidae).
Delteil 1.
Utetheisa pulchella (*Deiopeia*) (Bombycidae).
Köningsberger 1.

N. B. The contents of two apparently important papers are unknown to me, viz., Ragonot 1; Snellen 1.

ORDER HYMENOPTERA.

Parasites (general).
Ballou 1; Kobus 2; Espeut 1, 2; Köningsberger 1.
Ants (general).
Barry 1, 2.
Ablerus pulchriceps (Chalcidoideae).
Zehntner 23.
* *Ageniaspis sp.* (Chalcidoideae).
Swezey 3.
* *Alaptus immaturus* (Mymaridae).
Perkins 3 (pt. 6).
* *Anagrus frequens* (Myrmaridae).
Perkins 3 (pt. 6); Muir.
Anomalon sp. (Ichneumonidae).
Deventer 4.
Apanteles scirpophagae (Braconidae).
Nicéville 2.
Aphelinus mali (Chalcidoideae).
Zehntner 30.
A. simplex.
Zehntner 8.

Bracon nigrosignatus (Braconidae).
Deventer 4.
* *Cardiocondyla wroughtonii* (Formicidae).
Perkins 1.
* *Centistes americana* (Braconidae).
Perkins 1; Swezey 1.
Cephalotes cephalotes (Formicidae).
Schomburgk 1.
Ceraphron beneficiens (Proctotrypidae).
Deventer 4; Zehntner 3.
* *C. abnormis.*
Swezey 7.
Chaetosticha nana (Chalcidoideae).
Deventer 4; Krüger 3; Zehntner 3.
Chalcis carbonaria (Chalcidoideae).
Deventer 4.
C. sp?
Zehntner 20.
* *C. obscurata* [*obsurata!*]
Swezey 3.
* *Chelonus blackburni* (Braconidae).
Swezey 3.
Closterocerus tricinctus (Chalcidoideae).
Deventer 4; Zehntner 16, 20.
Cotesia flaviceps.
Cotes 3, 4.
* *Cryptid sp.* (Ichneumonidae).
Perkins 1.
Derostenus albipes (Chalcidoideae).
Deventer 4; Zehntner 20.
Dielis formosus [= *septemcinctus*].
Froggatt 1; Tryon 4.
Dorylus orientalis.
Alcock 1; Peal 1; Stebbing 1.
* *Echthromorpha maculipennis* (Ichneumonidae).
Swezey 3.
* *Ecthrodelphax fairchildii* (Dryinidae).
Perkins 1.

Elasmus sp. (Chalcidoideae).
Zehntner 26.
Encarsia flavoscutellum (Chalcidoideae).
Deventer 4; Zehntner 27.
Eulophus femoralis (Chalcidoideae).
Deventer 4; Zehntner 4.
* *Eurytoma sp.* (Chalcidoideae).
Swezey 3.
Formica analis vide Megaponera foetens.
F. cephalotes, vide Cephalotes.
F. rufonigra, vide Sima.
F. omnivora, vide Monomorium. *
F. saccharivora, vide Lasius.
F. vinsonnella.
Dufour 1.
* *Gonatocerus cingulatus* (Mymaridae).
Perkins 3 (pt. 6).
* *Gonatopus* (Dryinidae).
Perkins 3 (pt. 6).
Goniozus indicus (Dryinidae).
Nicéville 2.
* *Haplogonatopus vitiensis* (Dryinidae).
Swezey 7.
* *Hemiteles* (Braconidae).
Kirkaldy 10, Perkins 1.
* *Ichneumon koebelei* (Ichneumonidae).
Swezey 6.
Labolips (Proctotrypidae).
Zehntner 23.
Lasius saccharivorus (Formicidae).
Castles 1; Kirby and Spence 1; Schomburgk 1.
* *Leptogenys falcigera* var. *insularis.*
Swezey (not recorded).
* *Limnerium blackburni* (Braconidae).
Swezey 3.
Macrocentrus sp.
Deventer 4; Zehntner 26.

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* *Eciton omnivorum* (which ought to be called *E. coecum*) is quite a different form.

M. nicevillei.
Nicéville 2.
* *Macrodyctium omiodivorum* (Braconidae).
Swezey 3.
Megaponera foetens [*analis*] (Formicidae).
Kirby and Spence 1.
* *Melittobia hawaiiensis* (Chalcidoideae).
Swezey 8, 9.
* *Microdus hawaiicola* (Braconidae).
Swezey 8, 9.
Microgaster sp. (Braconidae).
Deventer 4.
* *Monomorium floricola* (Formicidae).
Perkins 1.
M. omnivorum.
Krüger 3; Schomburgk 1.
* *Odynerus nigripennis* (Vespidae).
Swezey 3.
* *O. spp.*
Swezey 8, 9.
Ooctonus australensis (Mymaridae).
Perkins 3 (pt. 6).
* *Ootetrastichus beatus* (Chalcidoideae).
Muir.
Ophion antankarus (Ichneumonidae).
Bordage 1; Howard 7.
O. mauritii.
Bordage 1; Howard 7.
* *Paranagrus optabilis* (Mymaridae).
Muir; Perkins 3 (pt. 6).
* *Paraphelinus xiphidii* (Chalcidoideae).
Perkins 3 (pt. 8).
* *Pheidole megacephala* (Formicidae).
Perkins 1; Swezey 8, 9.
Physcus flavidus (Chalcidoideae).
Zehntner 21.
* *Pimpla hawaiiensis* (Ichneumonidae).
Swezey 3.

* *Pison sp.* (Crabronidae).
Kirkaldy 10.

Pleurotropis thoracica (Chalcidoideae).
Zehntner 20.

* *Polistes aurifer* (Vespidae).
Swezey 3, 4.

* *P. hebraeus.*
Swezey 3.

* *P. macaensis.*
Swezey 3.

* *Polynema reduvioli* (Mymaridae).
Perkins 3 (pt. 6).

* *Prenolepis bourbonica* (Formicidae).
Perkins 1.

Prospalta tristis (Chalcidoideae).
Krüger 3; Zehntner 7.

* *Pseudogonatopus saccharetorum* (Dryinidae).
Perkins 3 (pt. 7).

* *Sceliphron caementarium* (Vespidae).
Kirkaldy 10.

* *Sierola dichroma* (Bethylidae).
Swezey 3.

* *S. molokaiensis.*
Swezey 8, 9.

Sima rufonigra (Formicidae).
Roth 1.

* *Tapinoma melanocephala* (Formicidae).
Perkins 1.

* *Tetramorium guineense* (Formicidae)
Perkins 1.

Tetrastichus sp. (Chalcidoideae).
Zehntner 27.

* *Trichogramma pretiosa* (Chalcidoideae).
Koebele 4; Swezey 3,

ORDER DIPTERA.

* *Chaetogaedia monticola* (Tachinidae).
Swezey 3, 6.
Chaetopsis aenea (Ortalidae).
Howard 5.
Diplosis acarivora (Cecidomyiidae).
Deventer 4.
* *Drosophila sp.* (Drosophilidae).
Perkins 1.
* *Eristalis punctulatus* (Syrphidae).
Perkins 1.
* *Euxesta annonae* (Ortalidae).
Eckart 1, Perkins 1, 9.
* *Frontina archippivora* (Tachinidae).
Swezey 3, 6.
* *Leucopis sp.* (Agromyzidae).
Kirkaldy 10.
Masicera sp.? (Tachinidae).
Deventer 4.
Phytomza sp. (Phytomyzidae).
Deventer 4; Krüger 3; Köningsberger 1; Zehtner 4, 13.
* *Pipunculus juvator* (Pipunculidae).
Perkins 1; Swezey 4.
* *P. terryi.*
Perkins.
* *Sarcophaga sp.* (Sarcophagidae).
Perkins 1.
Syrphid sp. (Syrphidae).
Deventer 4; Zehntner 30.
Tachina sp. (Tachinidae).
Koebele 4.
Tipula sp. (Tipulidae).
Deventer 4; Köningsberger 1; Krüger 3; Zehntner 13.
* *Volucella obesa* (Syrphidae).
Perkins 1.
* *Xanthogramma grandicornis* (Syrphidae).
Swezey 4.

CLASS ARACHNIDA.

Acari (unnamed).
Boger 1; Bancroft 3; Hooker 1; Michael 2; Roth 1, 2.

"*Acarus sacchari.*"
Nicol 1; Cameron 1.

* *Argyope avara* (Araneidae).
Kirkaldy 10; Perkins 1.

* *Argyrodes argyrodes* (Theridiidae).
Kirkaldy 10.

* *Artema sisyphoides* (Pholcidae).
Kirkaldy 10.

* *Bavia aericeps* (Salticidae).
Kirkaldy 10.

* *Cyclosa sp.* (Araneidae).
Perkins 1.

* *Dysdera crocata* (Dysderidae).
Kirkaldy 10.

* *Erigone vagans* (Araneidae).
Kirkaldy 10.

* *Hasarius adansoni* (Salticidae).
Kirkaldy 10.

* *Heteropoda regia* (Clubionidae).
Kirkaldy 10.

Histiosoma rostroserrata (Acarina).
Michael 1.

* *Lycosa sp.* (Lycosidae).
Kirkaldy 10.

* *Mollica microphthalma* (Salticidae).
Kirkaldy 10.

* *Pagiopalus atomarius* (Misumenidae).
Kirkaldy 10; Perkins.

Phytoptus sp. (Acarina).
Zehntner 13.

* *Plexippus paykulli* (Salticidae).
Kirkaldy 10.

* *Procrnus schauinslandi* (Misumenidae).
Kirkaldy 10.

* *Scytodes marmorata* (Sicariidae).
Kirkaldy 10.
* *Smeringopus elongatus* (Pholcidae).
Kirkaldy 10.
Tarsonymus bancrofti (Acarina).
Bancroft 1; Deventer 4; Krüger 3; Michael 1; Zehntner 13.
* *Tetragnatha mandibulata* (Araneidae).
Kirkaldy 10; Perkins 1.
Tetranychus exsiccator (Acarina).
Deventer 4; Krüger 3; Zehntner 13, 28.
* *Theridion tepidariorum* (Theridiidae).
Kirkaldy 10.
Tyroglyphus longior (Acarina).
Roth 1; Fumouze 1.

CLASS MYRIAPODA.

Scolopenudra subspinipes.
(Not recorded).

CLASS CRUSTACEA.

Paratelphusa maculata (Decapoda).
Deventer 4; Krüger 3; Zehntner 13.

PARASITES, OR ARTIFICIAL CONTROL

(Not classified above.)

Compere 1.
Craw 1, 6.
Espeut 1.
Froggatt 2, 3.
Howard 8.
Kirkaldy 13, 16.
Koebele 1.
Marchal 1.
Mead 5.
Silvestri 1.

The following references have not been classified above, for various reasons, either because they are too general in character, because I have not seen them, or for other reasons.

Fleutiaux 1.
Horner 1.
Johnstone 2.
Kotinsky 1.
Mead 1, 4.
Newlands 1.
Olliff 1.
Perkins 6, 8.
Ridley 1.
Terry 1, 5.
Turnbull 1.
Turner 1.
Whitney 2, 3.

SUMMARY OF GENERA AND SPECIES.

Order	Genera	Species
Neuroptera	4	7
Orthoptera	24	35
Thysanoptera	7	10
Hemiptera	57	81
Coleoptera	65	89
Lepidoptera	50	81
Hymenoptera	67	79
Diptera	15	18
Insecta	289	400
Arachnida	24	24
Crustacea	1	1
Myriapoda	1	1
	315	426

These figures are not exact, as several of the species are not positively determined.

N. B.—Throughout for "Köningsberger," read "Koningsberger."

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ENTOMOLOGICAL SERIES. BULLETIN No. 9

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

On Some New Species of Leaf-Hopper (Perkinsiella) on Sugar Cane.

BY F. MUIR

HONOLULU, HAWAII.
DECEMBER 16, 1910.

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the
Hawaiian Sugar Planters' Association,
Honolulu, Hawaii.

Dear Sirs: I herewith submit for publication, as Bulletin No. 9 of the Entomological Series, a paper prepared by Mr. F. Muir, entitled: "On Some New Species of Leaf-Hopper (Perkinsiella) on Sugar Cane."

Yours very truly,

C. F. ECKART,
Director.

Honolulu, Hawaii, October 19, 1910.

ON SOME NEW SPECIES OF LEAF-HOPPER (PERKINSIELLA) ON SUGAR CANE.

PERKINSIELLA Kirkaldy.

This genus was erected by Kirkaldy for *saccharicida* in 1903. It differs from *Dicranotropis* in the first joint of antennae being broader at the apex than at the base and both joints somewhat flattened, not cylindrical, also in the presence of two spines on ventral margin of pygophor. The genus is particularly attached to sugar cane (*Saccharum officinarum*), only occasionally going on to other grasses. The thirteen known species are distributed in the following manner:—

New Guinea 6, Amboina 3, Ceram 1, Java 4, Borneo 3, Australia 2, Fiji 2, Hawaiian Islands 1 (introduced), China 1.

From this it appears that it is a Malayan genus with its center in New Guinea. Considering the amount of sugar cane taken from island to island in native boats, it is surprising that some of these species have such a restricted range.

The males are best distinguished by the genitalia, otherwise the species may be separated as follows:

1. Frons concolorous. 2
   Frons darker between eyes than below. 5
2. Vertex, pronotum, and scutellum lighter than frons and clypeus. *fuscifrons*
   Vertex, pronotum, and scutellum not lighter than frons and clypeus. 3
3. Veins on tegmina apparently white, sparsely granulated. *vastatrix*
   Veins on tegmina apparently dark, closely granulated. 4
4. Median, radial, and cubital cells clear; longitudinal markings on femora very faint. *amboinensis*
   Median, radial, and cubital cells dark; longitudinal markings on femora plainer. *lalokensis*

5. Spur on hind leg same color as tibia. 6
   Spur on hind leg darker than tibia. 9
6. Tegmina divided into two longitudinal parts by the median, 5th cubital, and all cells posterior to them (including clavus) being dark; all anterior clear. *bicoloris*
   Tegmina not so colored. 7
7. Pattern on tegmina formed by brown and yellow on clear cells. *variegata*
   Pattern on tegmina formed by brown on clear cells (no yellow) 8
8. Pattern on tegmina on 5 and 6 apical cells, granules on veins pallid and fine. *saccharicida*
   Pattern on tegmina on 6 and at each end of 5 apical cells, making curved pattern; granules on veins dark and coarse. *sinensis*
9. Scutellum concolorous. 10
   Lateral parts of scutellum darker than middle. 11
10. Tegmina almost immaculate, some of apical veins lightly infuscate; granules inconspicuous and very sparse. *vitiensis*
    Tegmina with granulation darker and coarser (all females brachypterous). *graminicida*
11. Antennae concolorous, dark. *papuensis*
    Antennae not concolorous. 12
12. Head and thorax light, veins on tegmina sparsely and finely granulated. *pallidula*
    Head and thorax dark, granules on tegminal veins closer and coarser. *rattlei*

1. *saccharicida* Kirkaldy, 1903, Entom. XXXVI., 179.

I have one male specimen from Viti Levu, Fiji, probably imported from Queensland with cane. It is possible that New Guinea species will eventually be recorded from the same locality, as much sugar cane has been imported direct from that locality.

2. *vitiensis* Kirkaldy, 1906, Bull. H. S. P. A. Ent. I, 406.

3. *graminicida* Kirkaldy, 1906, Bull. H. S. P. A. Ent. I., 406.

4. *sinensis* Kirkaldy, 1907, Bull. H. S. P. A. Ent. III., 138.

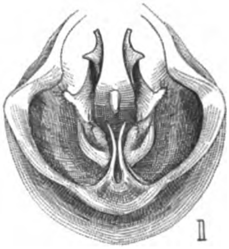
I have one macropterous female specimen from Telok Ayer, West Borneo, that agrees with the Chinese males, except that the dark mark runs down apical cell 6 instead of 5.

5. *pallidula* sp. nov.

Female macropterous. Antennae, frons between eyes, clypeus, lateral edges of pronotum, and scutellum, light brown; frons below eyes, vertex, pronotum, and scutellum between lateral keels, and rest of thorax and legs yellowish. Pleural spot very faint. Anterior and intermediate tarsi, band on anterior and intermediate femora, and spur, blackish. Abdomen, yellowish. Tegmina, hyaline; clavus, light brown; dorsum, white with dark spot before end of anal vein; dark brown at base and near apex of 5, and greater part of 6 and 7 apical cells, leaving a light spot near apex of these cells; veins, light, sparsely studded with brown granules. Length of female 3 mm, 4 mm.*

Habitat, Pontianak, Borneo, on sugar cane. This comes near to P. *sinensis*, but I have specified it, as it is much more uniform and light in color. The presence of a dark band on the femora, and not longitudinal marks, and the black spur distinguish it. The granules on veins are less distinct than in *sinensis*, but more so than in *saccharicida*.

6. *rattlei* sp. nov. (Fig. 1.)



***First measurement front of vertex to end of abdomen, second measurement to end of tegmina.**

Male macropterous. Head, antennae, and thorax, brown; frons between eyes, clypeus, lateral edges, pronotum, scutellum, and distal part first antennal joint, darker; keels and spots on frons, lighter. Anterior and intermediate tarsi, band on tibiae and spur, dark; also longitudinal marks on femora, pleural spot, plain. Dorsum, inner margin or edge of clavus, abdomen, black with brown markings along sides. Tegmina, hyaline, suffused with light brown. Radial and median cells, dark brown, running into central part of subcostal cell. Apical cells 2 to 8, dark brown with light spots in 2 to 4 and 6 to 7, also in radial and median. Veins closely granulated. Anal tube with claw-like, curved spine; genital styles, large antler-like, reaching beyond middle of pygophor, basal part thick and slightly concave, with small protuberance in middle, distal part flattish provided with blunt prong on outer side and apex drawn out into two flat prongs. Ventral spines, thin, smooth, cone-shaped, curved, touching in center, but not at base or tips.

Female macropterous, somewhat lighter in color than male, especially the abdomen. Dark marks on tegmina confined to along the apical veins, especially the distal part, and along base of 5 to 6 apical cells. Length, female, 4.5 mm, 6 mm; male broken.

Habitat, Laloki River, British New Guinea, on sugar cane.

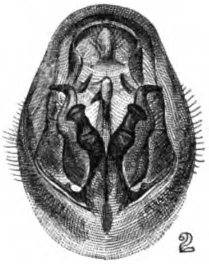
This species comes near to *lalokensis* and *amboinensis*, but the light frons below the eyes makes it easy to distinguish.

7. *bicoloris* sp. nov.

Female macropterous. Antennae, frons between eyes, clypeus, lateral margins of pronotum, and scutellum, piceous brown, with light spots on frons; frons between eyes and apex of clypeus, white, with dark sub-apical line across former; vertex and pronotum and scutellum between lateral keels, yellowish. Legs, light; posterior and intermediate tarsi and band on tibiae, piceous, with longitudinal markings on femora. Pleural dark spot, plain. Abdomen, dark, marked with light brown. Tegmina, hyaline; dark on clavus; median, discoidal and 5 to 6 apical cells, dark along 1 to 4 apical veins. Veins finely granulate. Only females taken, length 3 mm, 5 mm.

Habitat, Laloki River, British New Guinea, on sugar cane.

8. *variegata* sp. nov. (Fig. 2.)



Male macropterous. Vertex, pronotum, and scutellum, yellowish brown, broadly whitish along keels; antennae, frons between eyes, and clypeus brown, former with light spots; frons below eyes and apex of clypeus, white. Legs, white; anterior and intermediate tarsi and band on tibia, dark; dark longitudinal mark on femora; spur, light. Pleural spot, small. Abdomen, piceous, marked with brown. Tegmina, hyaline; yellowish between dorsum and axillary veins and across distal part of subcostal cell; between anal and axillary veins, basal half of median and spreading into radial, 5 to 8 apical cells, also along apical vein 2 to 4, dark brown; white spot at edge of 5 to 7 and across middle of 5 apical cells. Veins, light, granules exceedingly fine and sparse. Anal spines curved, pointing distally. Genital styles large, reaching past middle of pygophor, horn-shaped and twisted, without any lateral prongs. Ventral spines large, reaching about to middle of pygophor, sub-cylindrical and rounded at ends, swollen about middle, from which point they divaricate. The pattern on wings and large ventral spines distinguishes this species.

Female macropterous, similar to male, except the abdomen, which is lighter. Length: male 2.5 mm, 4 mm; female, 3.5 mm, 5 mm.

Habitat, Laloki River, British New Guinea, on sugar cane.

9. *papuensis* sp. nov.

Female macropterous. Antennae, frons between eyes, clypeus, lateral edges of pronotum and scutellum, black, with light spots on frons between eyes; frons below eyes and apex of clypeus, white; sub-apical dark marks between keels on frons; vertex, pronotum, and scutellum, yellowish between white keels. Legs, whitish; anterior and intermediate tarsi, band on tibiae, and spur, black; dark longitudinal marks on femora. Large black pleural spot. Abdomen, black. Tegmina, hyaline, suffused with brown on clavus; dorsum, white; black dot at end of anal vein; apical cells 5 to 8, and running into discoidal and median cells, dark brown, also along apical veins 1 to 4; white spot at apex of 5 to 8, and center of 5, apical. Veins, thickly studded with dark granules.

This is a very distinctly contrasted species represented only by a female. Length, 3.5 mm, 6mm.

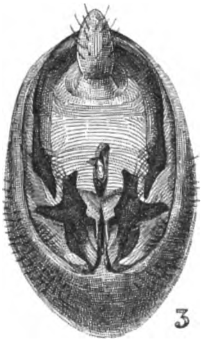
Habitat, Laloki River, British New Guinea, on sugar cane.

10. *vastatrix* (Breddin).

I have specimens of both sexes of this species from Java, West Borneo, Amboina, Piroe (Ceram), and Laloki River (British New Guinea). There is a distinct darkening of the wing pattern as we pass eastward.

The spine on anal tube is bifurcate.

11. *lalokensis* sp. nov. (Fig. 3.)



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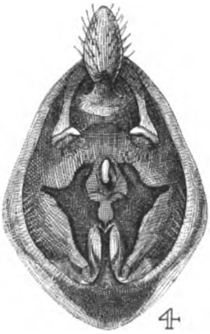
Males macropterous. Head, antennae, thorax, and legs, brown, with small lighter spots on frons. Apex of first antennal joint, black. Lateral margins of pronotum and scutellum, dark. Large, black pleural spot. Anterior and intermediate tarsi, and apex of tibiae, banded with black. Tegmina, hyaline, suffused with brown. Dorsum, white to end of clavus; black spot on apex of anal vein. Apical cells 4 to 8, and along apical veins 1 to 3, dark brown, continuing into distal part of radial, median, and inner discoidal cells; light spot in distal cells 6 to 8. Veins, dark, finely granulated. Anal tube large, with a pair of straight, somewhat bulbous spines reaching beyond middle of pygophor. Genital styles, broad, flattish, distal end cut off square, outer edge giving out blunt prong half way down and inner edge small blunt knob. Ventral spines, thin, touching from base to tip.

Female dimorphic, macropterous forms similar to male, excepting abdomen which is lighter; brachypterous forms lighter with the spot at apex of anal vein and a spot at end of radial cell. Length, males 3 mm, 5 mm; females, 5 mm, 6 mm; brachypterous females 4.5 mm, 4 mm.

Habitat, Laloki River, British New Guinea, on sugar cane.

12. *amboinensis* sp. nov. (Figs. 4 and 5.)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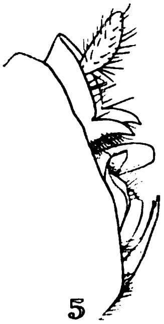
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Males macropterous, markings on head and thorax similar to *lalokensis*, but lighter, especially the legs. Tegmina, brownish hyaline. Apical cells 4 to 7 and base of 3 dark. also along apical veins 2 to 3, light spot in apical cells 4 to 7. Dorsum, whitish to end of clavus, spot at end of anal vein, faint. Veins, dark, finely granulated.

Pygophor approaching *lalokensis*, anal tube with a pair of curved, claw-like spines pointing distally. Genital styles, broad, flattish; distal end and prong on outer edge less square than in *lalokensis*. Ventral spines, thin, diverging near apex.

Female macropterous; tegmina often slightly darker than male; light spot in apical cell 4 sometimes missing. Length, male, 3 mm, 4.5 mm; female, 4 mm, 6 mm.

Habitat, Island of Amboina, on sugar cane.

13. *fuscifrons* sp. nov.

Pronotum and scutellum, light brown, darker on lateral edges, keels whitish. Vertex and frons, brown, slightly lighter between eyes than below; keels, small spots on frons, and a line across apex, whitish; clypeus darker than frons. Front and intermediate tarsi and bands on tibiae, dark; femora, dark. Black pleural spot. Tegmina, hyaline, yellowish between axillary vein and dorsum; dark spot at end of anal vein; dark along tips of apical veins; base of apical cell 5 and across apical cell 6. Only females taken. Length, 2.5 mm, 4 mm.

Habitat, Island of Amboina, on sugar cane.

The frons and clypeus darkening towards the apex, together with the light dorsal and dark ventral aspect, distinguishes this species.

PHACALASTOR.

Phacalastor pseudomaidis Kirkaldy, 1906, Bull. H. S. P. A. Ent. I. 408, was placed by its author in the genus *Perkinsiella* (1907 Bull., H. S. P. A. Ent. III., 136, Plate XIII., Figs. 1-2) on account of the pair of ventral spines, but the specimen examined and figured had the oedeagus abnormally extruded and laying on the prolongation of the ventral edge of the pygophor, the two spines seen belong to the oedeagus. This pygophor is of the same type as *P. koebelei* Kirkaldy, so I place them together again in that genus.

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ENTOMOLOGICAL SERIES BULLETIN No. 10

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Parasites of Insects Attacking Sugar Cane

By R. C. L. PERKINS

HONOLULU, HAWAII
1912

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the Hawaiian
Sugar Planters' Association,
Honolulu, Hawaii.

Dear Sirs:

I herewith submit for publication as Bulletin No. 10, of the Entomological Series, an article by Dr. R. C. L. Perkins, Enomologist, entitled: "Parasites of Insects Attacking Sugar Cane."

Yours very truly,

C. F. ECKART,
Director.

Honolulu, February 26, 1912.

Parasites of Insects Attacking Sugar Cane.

By R. C. L. PERKINS.

In this Bulletin is described a number of very minute parasites, nearly all of which were bred from eggs of insects attacking cane in countries other than these islands.

The American species were obtained by Mr. Koebele, when investigating insects in the cane fields in Mexico, where he spent a short time during the winter months of 1908. All the rest were obtained by Mr. Muir in Fiji, China and the Malay islands. Many of these parasites are of great interest and importance, since they are important agents in limiting the numbers of injurious species, which, if introduced into the islands without their parasites, would be likely to cause great loss to the sugar plantations. It has been advisable, therefore, to work out these insects and put them on record, so that in the event of any of the species which they attack turning up in the islands, information would be at hand as to where to look for natural enemies without delay. Although there is now a regular inspection of all imported plants and, without doubt, the vast majority of injurious insects is intercepted and destroyed, yet there are means of introduction which no inspection can provide against. Also there are some insects which are liable to be passed over by the most shrewd inspector and against which treatment by fumigation is ineffective. We know that in spite of the fact that there has been a systematic inspection of introduced plants for nine years, during the last few years numerous new insects have appeared and become abundant. Because this is the case there is no reason to regard inspection as futile, for as has been said, there is no doubt that the majority of imported species is thereby prevented from becoming established. With the opening of the Panama Canal and with quick steamers from Central America we may safely predict that an entirely new lot of insects will be brought here, and that the duties of inspectors will become still more onerous. Many of these insects will be particularly dangerous, because we know that species from the warmer parts of the American continent readily become established and thrive here, whereas the native insects of California though they have often been brought here, generally fail to establish themselves. This climate is evidently not suited to them. Although cane is no longer imported into the islands, yet many bad cane pests are by no means restricted to cane, but may easily be brought with other plants. It is well known that steamers have put in here from Fiji carrying cane on board, from which insects might easily have escaped to the shore, although such cane is not landed. It is also known that both on cane and on other plants, carried on deck, insect pests are frequently numerous. Mr. Muir has observed this to be the case with sugar cane carried on deck from Fiji, and Mr. Koebele and myself noticed great quantities of fruit fly maggots dropping from fruit carried on the deck of steamers, when we were traveling along the Australian coast. These fruit-fly maggots were crawling into cracks of the deck and pupating there and some would certainly be likely to hatch out and gain the shore at other ports. Quick travelling steamers may carry even mature insects an enormous distance, so that they reach new countries by flight, when in or near port. Mosquitoes were still seen on board the ship on my last journey to San Francisco, five days after leaving Honolulu. On another journey numbers of a Chinese moth were seen about the decks the whole way to San Francisco. It would be very difficult and probably impracticable to keep such things from becoming established in a country suitable to them.

CHALCIDOIDEA

EULOPHIDAE

The species of this family here described belong to two subfamilies, the Eulophinae and Tetrastichinae. Only one species *Closterocerus javanus* belongs to the former, and I suspect that it is hyperparastic, attacking one or more species of the egg-parasites of Delphacid leaf-hoppers, these parasites belonging to the genus *Ootetrastichus.* The Tetrastichinae are chiefly represented by the latter genus, of which seven new species are here described. The members of this subfamily were supposed by the late Dr. Ashmead to be hyperparasites, but it is now known that many are primary parasites. They are of great importance in the Oriental region in limiting the number of various species of sugar-cane leaf-hoppers. Another Tetrastichine, *Neotetrastichus mimus* I cannot fit into any hitherto described genus. It is superficially extremely similar to some of the species of *Ootetrastichus,* but it has very different antennae.

Ootetrastichus.

Ootetrastichus Perkins, Bull. Exp. Station Hawaii, I, 263.

This genus was founded for the single species O. *beatus* Perk., of which only the female was known. It is remarkable in this sex for the 7-jointed antennae, which possess in addition apparently three ring-joints, or even sometimes have the appearance of bearing four such joints.

Although O. *beatus* has now been under observation for seven or eight years and has been bred generation after generation for long periods of time, no male has ever been seen, either in these islands, where it is fully established and now very common, or elsewhere.

On the other hand the males of four other species, described below are now known. In general structure they are like the females, but even in life their sex would be easily recognized by the enormously dilated scape of the antennae. These organs are unlike those of the female, having two additional joints, the complex nature of the ring joints being the same in each sex. The scape of the male is ovate, long and large; there are four elongate funicle joints, not usually differing very much in length, and a distinctly three-jointed club. In one species (*O. holochlorus*) the marginal vein is notably thickened and in some males there is a sexual modification of the apical joint of the front tarsi.

SYNOPSIS OF SPECIES

1. Antennae with 9 joints in addition to ring-joints (males) 10
   Antennae with 7 joints in addition to ring-joints (females) 2
2. Hind coxae pale, not metallic 3
   Hind coxae dark, metallic 5
3. Mesonotum with conspicuous dark area in front, this area metallic in dry examples ....*O. beatus*
   Mesonotum without metallic dark area in front.

4. Lateral spots of abdomen distinct, propodeum with some infuscation .... *O. tarsalis*
   Lateral spots of abdomen absent or inconspicuous, propodeum entirely pallid .... *O. holochlorus*
5. Thorax and abdomen not wholly dark 6
   Thorax and abdomen wholly dark .... *O. metallicus*
6. Thorax wholly metallic 7
   Thorax largely pale, the propodeum mostly dark and metallic, mesonotum with dark spots, etc. .... *O. muiri*
7. Basal half (or nearly) of abdomen pale (whitish or pale yellow) 8
   Basal part of abdomen somewhat paler than the apical, but the paler part with darker lateral markings..... .... *O. pallidipes*
8. First funicle joint extremely long, three times as long as wide where widest .... *O basalis*
   First funicle joint much shorter, at the most rather more than twice as long as wide 9
9. First funicle joint longer than the second, *O. homochromus*
   First funicle joint subequal to the second, *O. distinguendus*
10. Hind coxae pale 11
    Hind coxae dark 12
11. First funicle joint subequal to the second... *O. holochlorus*
    First funicle joint much longer than the second, *O tarsalis*
12. Whole thorax dark and metallic .... *O. basalis*
    Thorax pale with dark markings or at least with the mesonotum on its posterior half pallid 13
13. Mesonotum dark only near its front margin; scutellum pale, at most slightly infuscate and not metallic, abdomen not wholly dark on the apical segments, *O muiri*
    Mesonotum dark on fully its anterior half, scutellum notably darkened and metallic, apical part of abdomen wholly dark and metallic .... *O. pallidipes*

(1) *Ootetrastichus holochlorus* sp. nov.

Entirely pallid, yellowish, very probably green in life, the head in dead examples generally darker than the thorax. The thorax bears a few extremely small dark spots or infuscations; one at the hind angles of the pronotum and another close to the tegulae are probably always present, black or nearly so. Legs entirely pallid, except the extreme tips of the tarsi; apex of the sheath of the ovipositor also dark. Neuration pale.

Antennae of the female with seven distinct joints, scape, pedicel, three-jointed funicle and two-jointed club. Between the pedicel and funicle there is an appearance of three ring-joints as in *O. beatus,* the type, and in other species of the genus. First funicle joint less elongate than is usual in the genus, only about one and a quarter or one and a third times the length of the second; club rather longer than two preceding joints together and slightly shorter than the first and second funicle joints together.

Male with the scape greatly dilated, with rounded sides, ring joints as in the female or even apparently four transverse divisions visible; first funicle joint elongate, twice as long as wide, but slightly shorter than the second, the four funicle joints not differing much in length. The club is distinctly three-jointed and is much longer than the two preceding joints together, but not so long as the three preceding. The male therefore has one distinct club-joint and one distinct funicle joint more than the female, and apart from the antennal characters differs from the latter in having the marginal vein of the front wings much thickened or wider. The apical joint of the front tarsi is also widened and black. Length .66—1.2 mm.

Hab. Java, Pekalongan, No. 280 (Muir). From eggs of Delphacid on sugar-cane, either *Perkinsiella saccharicida* or *vastatrix.*

(2) *Ootetrastichus tarsalis* sp. nov.

Pallid, flavescent, generally similar to *O. beatus* and *O. holochlorus,* the pattern of markings in most respects like these.

Head pale, each ocellus more or less enclosed in a dark ring. Posterior angles of pronotum, the parapsides and axillae anteriorly, two spots at the base of the tegulae, an area on each side of the middle line of the propodeum, black or fuscous. Abdomen with five distinct lateral spots on each side, a pair to each segment, the basal pair sometimes less evident. In the male the fifth pair of spots are notably enlarged and tend to form a fascia. The spot at the front of the parapsides is sometimes faint or absent. No dark and metallic area on the mesonotum in front. All the coxae pale. Antennae of female with first funicle joint very long, about four times as long as wide, second much shorter, about two-thirds as long as the first, and subequal to the third. Antenna of male with the usual sexual differences, the scape greatly dilated, the first funicle joint much longer than is usual in this sex, very similar to that of the female, being slender and elongate, and very much longer than the second, the latter and the two following not differing much in length, but the second is much slenderer, the third and fourth being subelliptic.

Fourth joint of front tarsi in the male much widened, black and clothed with black hairs. Length .8—1.25 mm.

This is a very distinct species, the female being distinguished from that of *O. beatus* by the absence of the dark metallic areas on the front part of the mesonotum. The male differs greatly from *O. holochlorus* and other species, in the long first funicle joint of the antennae and has the apical joint of the front tarsi more highly modified.

Hab. Amboina (No. 445); host as in the preceding.

(3) *Ootetrastichus muiri* sp. nov.

Yellow (or probably greenish in life) becoming more sordid after being mounted in balsam, and the head more reddish. Conspicuous black thoracic marks are placed at the front of the mesonotum, the hind angles of the pronotum, the anterior angles of the parapsides, on the axillae, and between these and the tegulae, as in *O. beatus*. There are also lateral abdominal spots as in that species.

The metathorax (post-scutellum) and most of the propodeum, including the middle and sides, are dark, as also are the hind coxae and a large part of the mesopleura. All the dark markings are of a metallic green color in certain lights. The color of the male is in general like that of the female, but the black markings near the apex of the abdomen are more developed and appear to form a dark band. Antenna of the female nearly similar to that of *O. beatus;* in the male the scape is ovate, enormously dilated, the pedicel about equal to the first or second funicle joints, which are subequal, the first being three times as long as wide or rather more than this. There are four distinct funicle joints and three club joints. There are probably two ring joints, these having the appearance of being three. Length 1.5 mm.

Hab. China, Shek Lung (Muir); eggs of cane Delphacid.

(4) *Ootetrastichus basalis* sp. nov.

Thorax metallic green, abdomen pale on about the basal half. the apical part being dark and with metallic reflections. Legs and antennae more or less sordid, and the head brown in balsam preparation. Middle and hind coxae black or nearly so, and no doubt metallic. Antennae of female with the first funicle joint very long, about one and a half times the length of the elongate second, and about five times as long as its own width near the apex of the joint, third joint rather more than twice as long as wide; club nearly equal in length to the two preceding joints together. Thorax microscopically longitudinally rugulose; the abdomen elongate, as long or longer than the head and thorax together.

Male with the thorax wholly dark and metallic, the hind coxae conspicuously so, except at the apices, which are pallid. The abdomen is pale yellow or whitish basally, black or dark and metallic on the apical segments. The antennae have nine distinct joints, scape, pedicel, four funicle joints and a three jointed club, in addition to two or three ring joints. The scape is ovate and of enormous size, being greatly dilated, the first and second funicle joints are elongate, slender and subequal, the two following are more robust, especially the fourth. The marginal vein is normal, not noticeably thickened.

I have examined one female and three males of this species. The latter are mostly more or less discolored. They appear to closely resemble the female in color, but the abdomen is perhaps more extensively pallid. Length .8—1.5 mm.

Hab. Java, Pekalongan (Muir); from eggs of cane Delphacid.

(5) *Ootetrastichus homochromus* sp. nov.

Like *O. basalis* in appearance, the thorax and hind coxae dark and metallic, the base of the abdomen widely, and the legs, including the front and middle coxae, pallid.

This species is easily distinguished from *O. basalis* by the length of the first funicle joint of the antennae, which is distinctly but not greatly longer than the second, and is only about twice as long as its greatest width, subequal to the pedicel or a trifle longer. Length 1.2 mm. The male is not known.

Hab. Amboina (Muir); from eggs of *P. vastatrix.*

O. homochromus var. *dubiosus* nov.

Like the preceding, but with longer first funicle joint, this being distinctly longer than the pedicel, and also distinctly more than twice as wide as long. Male not known.

Hab. Amboina.

(6) *O. distinguendus* sp. nov.

Like the two preceding in form and color but easily distinguished by the comparatively very short basal funicle joint, the elongation of which is usually so characteristic of the genus. This joint is a little shorter than the pedicel and of the same length, or very nearly so, as the second funicle joint. Male not known. Length 1 mm.

Hab. Amboina.

(7) *Ootetrastichus pallidipes* sp nov.

The thorax is metallic, the mesonotum in part at least, being paler than the pronotum or the hind part of the thorax, and it has a more golden metallic color. The head is more or less pale, though somewhat infuscate. The mesopleura and mesosternum are dark and metallic, as also the hind coxae, but all the femora, tibiae and tarsi (except the tips) are pale, clear yellow. The abdomen is paler on the basal segments than on the apical ones, but the former have darker lateral infuscations.

The antennae do not present any striking character, the first funicle joint being much longer than the second, the second fully twice as long as its greatest width. The abdomen is long and pointed at the apex, not twice as long as the thorax, but more than one and a half times as long; the ovipositor sheath in the unique example is subexserted and black or nearly so.

The male which I refer to this species differs rather remarkably from the female, in having the hind part of the mesonotum clear yellow and apparently not metallic. The whitish basal portion of the abdomen bears a pair of blackish spots on each side. The antennal characters do not differ much from those of other species, the fourth funicle joint being evidently wider and slightly shorter than the second. The head is yellow, unless discolored. Length 1.5 mm.

Hab. Java, Pekalongan (Muir); bred in company with *O. holochlorus.*

(8) *Ootetrastichus metallicus* sp. nov.

Female entirely dark, the thorax metallic green, the abdomen dark brown or black, less conspicuously metallic than the thorax and like the head becoming paler in balsam preparations. The legs and antennae are more or less infuscate or smoky.

The pedicel, second and third funicle joints do not differ much in length, the first funicle joint (not counting the ring joints) is very long, about one and a half times the length of the second or third, the club is as long as the two preceding together, its apical joint being much longer than the basal. Thorax with very distinct longitudinal rugulosity, the scutellar grooves very distinct. Abdomen elongate, when fully extended longer than the head and thorax together. Length 1—1.2 mm.

Hab. Java, Pekalongan, No. 280 (Muir); bred in company with *O. holochlorus.*

Neotetrastichus gen. nov.

Head transverse, but rather large, the ocelli in a triangle, the outer ones remote from the eye-margins, each being much more distant from the nearest eye than from anterior ocellus. Antennae nine-jointed with the one ring joint, the scape simple, elongate, with a short basal pedicel, three funicle joints all elongate and subequal, the pedicel also subequal to these, the club elongate, three jointed, subequal to the two preceding joints together, or a little longer than these, the apical joint terminating in a long spine, not much shorter than the rest of the joint. The antennae are clothed, but not densely, with long hairs. Thorax of the usual Tetrastichine structure, the mesonotum without a median groove, the scutellum with two pair of grooved lines. Front wings somewhat densely hairy, blunt and broad at the apex, stigmal vein prolonged apically with three or four circular bubble-like granules; marginal cilia short, the longest not more than one-quarter as long as the greatest width of the wing. Hind wings very acutely pointed at the apex, discal cilia of apical portion very sparse. Abdomen somewhat robust, subequal to the thorax in length; ovipositor sheath stout, not extended behind the dorsum of abdomen. Female.

Neotetrastichus mimus sp. nov.

Thorax entirely dark, no doubt metallic in dry mounts, legs and basal abdominal segments pallid yellow, apical segments dark like the thorax. Antennae infuscate, pedicel more or less pale, head pale more or less reddish, or orange in balsam; hind femora dark at extreme base above.

Three funicle joints subequal, or the first very slightly shorter, second and third about three times as long as the greatest width, first club joint twice as long as wide but much shorter than the preceding funicle joint. Thorax apparently with excessively fine surface sculpture, hardly visible even under high powers. Neuration pale. Abdomen clothed with sparse dark hairs; sheath of ovipositor dark. Female. Length 1.5 mm.

Hab. China, Macao; bred from *Agromyza* mining leaves of *Vigna sinensis.*

Closterocerus Westwood.

I assign to this genus a minute species of brilliant metallic color, which in some respects differs in its characters from those given by Ashmead, who was acquainted with a number of species of the genus. The penultimate and antepenultimate antennal joints are not transverse.

Closterocerus javanus sp. nov.

Metallic blue and green, in balsam becoming piceous, and less brightly metallic. Legs pale yellow (at least in the female) the coxae all dark, the hind femora also conspicuously dark, the tips being pallid. Pedicel of antennae notably dark by reflected light, the following joints paler.

Antennae of female eight-jointed with the ring joint, the latter sometimes hardly distinguishable, except after treatment with potash. The pedicel is large and elongate, longer than the ring-joint and two following joints together; the fourth antennal joint (counting the ring joint) is about as long as wide, and smaller than the next following, the sixth is longer than its greatest width, the seventh still more elongate, while the eighth without including its spinose prolongation is as long as, or longer than the seventh, and with this prolongation not much less than twice as long.

The antenna of the male is almost like that of the female, but the fourth and eighth joints appear rather longer, the latter with its apical prolongation being a little longer than the two preceding together. In both sexes the flagellar joints are clothed with long hairs, longer than the joints bearing them. They also bear sparse short spinose or scale like processes, the longest of which is situated at the base of the spinose prolongation of the apical joint.

Thorax with conspicuous microscopical reticulation, the surface shining. Wings not very densely hairy, the clothing terminating basally in an angle before the base of the marginal vein; longest marginal cilia in length about one-third the greatest width of the wing; submarginal vein shorter than the marginal; stigmal longer than the post marginal, a distinct roundish smoky spot occupying the middle of the wing from costal to dorsal margin and including the stigmal vein; the latter with a prolongation of four round bubble-like granules from its posterior side before the apex; mediodiscal cilia absent from the apical portion of the hind wings. Abdomen of the female elongate-ovate, pointed, rather less than twice the length of the thorax, brilliantly metallic (normally purple) at the base; ovipositor not or hardly exserted. Abdomen of male about equal in length to the thorax. Length .7—1 mm.

Hab. Java, Pekalongan; in company with *Ootetrastichus;* bred from cane.

TRICHOGRAMMIDAE.

Two of the species of this family here described, were reared from the eggs of Jassidae, attacking sugar-cane in Mexico. One of these I cannot place in any of the numerous genera described by Girault, who has done excellent work on the North American species. This family has been divided into two subfamilies on the character of the hairs on the wing, but it appears to me than this division is unnatural, separating genera that are really allied, and even as a matter of convenience is of little practical use, since it is quite doubtful to which family certain forms should be referred. This is the case with the genus *Jassidophthora* described by me. All the Trichogrammidae known to me have a sessile abdomen, penetrated by the thoracic phragma, and by the longitudinal thoracic muscles. This is also the case with the Aphelininae of the family Eulophidae and with certain of the Mymaridae, but is otherwise rarely seen in the Chalcid series of families. The species of *Pentarthron* here described, destroys the eggs of the very injurious moth-borer, *Diatraea saccharalis.*

Westwoodella plebeia sp. nov.

Yellow, the head dark, sordid brown, meso- and metapleura above the coxae conspicuously dark, like the coxae themselves, trochanters yellow, the femora and tibiae embrowned or darkened, the apical joint of all the tarsi black or blackish. The basal abdominal segment above is more or less dark, as also is the sheath of the ovipositor, and generally more or less of the apex of the abdomen. Pronotum sometimes infuscate. Wings hyaline, the apex of the submarginal vein blackened and with a faint trace of infuscation below on the basal side of this dark line, stigmal vein (except its apical prolongation) mostly infuscate, the infuscation being continued narrowly downwards, the whole forming a curvate dark marking, reaching the middle of the width of the wing. Antennae 7-jointed, with a distinct ring joint; the single funicle joint is elongate, and when seen in its widest aspect is not much less than twice as long as wide, the pedicel is very elongate, being much longer than the ring joint and funicle together, but not twice as long as the funicle joint alone. The club is subequal to the pedicel, ring joint and funicle together, its basal joint at its widest is nearly as wide as long, and is about equal in length to the following joint, the apical joint is pointed and has a spinose apical prolongation on each side; the club is much wider than the funicle joint. The front wings are narrow, about three and a half times as long as their greatest width, the longest cilia about two-thirds as long as this width, the discal ciliation is irregular and not dense, terminating beneath the stigmal vein, basal of which the wing is almost free of hairs. The marginal vein is very long, fully as long as the submarginal, the stigmal is moderately long and is excised at the apex, so as to form two processes, one directed transversely to the wing, the other directed apically. The hind wings are covered with microscopic roundish infuscations of the membrane, rendering them notably darker than the front ones; they bear a single row of upright setae placed well within the costal margin, but much nearer this than the dorsal, in addition to the longer hairs on or close to the costa; the spine bearing the hooks, by which the wings are united for flight, is elongate and very strong. Abdomen stout, not elongate. Length .75 mm.

Hab. Mexico, Orizaba, Vera Cruz, Jan. 4th, 1908; from Jassid eggs on sugar-cane.

Jassidophthora gen. nov.

Head rather large, the lateral ocelli remote from the eye margins. Eyes with very short and sparse microscopic hairs. Antennae of female 9-jointed; scape, pedicel, ring-joint, 3-jointed funicle and 3-jointed club. Scape cylindrical, pedicel large obovate or obconical, nearly twice as long as the ring-joint and funicle together, club as long or longer than the pedicel, ring-joint and funicle together, three-jointed. The first funicle joint might almost equally well be considered as a second ring-joint, but it is very closely associated with the second funicle-joint and generally continues the outline of the latter; third funicle joint smaller than the second, which is the largest, and all are short and transverse. Antennae of male hardly different from those of the female.

Front wings not very wide, more than twice as long as wide, where widest; submarginal vein greatly thickened on less than its apical half, its basal slender portion subequal to the elongate marginal vein, the stigmal vein shortish and robust, with acute projection on the apical side. Discal ciliation consisting of about a score of lines, where the wing is widest, two or three of the lines more or less distinct from the others, especially two near the middle of the wing, one of which originates from the free end of the stigmal vein, the other below this and subparallel to it, but even these lines only stand out clearly defined on their basal part. On the costal half of the wing the cilia are quite irregular. Hind wings with two rows of discal hairs, neither of which is median in position. Abdomen of female acute at apex, elongate, longer than head and thorax together.

Jassidophthora prima sp. nov.

Face and front of head infuscate, the antennae more or less darkened, but the short funicle is quite pale. Pronotum and mesonotum black or nearly (or dark fuscous in balsam) the mesonotum with a yellow median line, united with the yellow hind margin; the axillae are dark, the scutellum, postscutellum and propodeum (except at the sides) yellow. Abdomen more or less sordid yellow or reddish, dark or black at the sides and basally, by transmitted light with an appearance of obscure bands. Color of male very similar, perhaps generally paler. Coxae, basal joint of trochanters and the femora notably dark to a large extent, the tibiae paler, but still somewhat infumate. Wings clear hyaline with a distinct smoky cloud enclosing the stigmal vein, on which it appears darkest, and subinterrupted above the dorsal margin, where it is again quite distinct; the wing basal of this is somewhat irregularly smoky. Longest cilia of front wing about one-third to one-fifth as long as the greatest width of the wing, apparently longer in the male than in the female. Scutellum with a pair of black bristles widely separated and a pair of stronger ones posterior and interior to these, but far in advance of the hind margain. Sculpture extremely fine and indistinct. Length .6—.75 mm.

In life the dark parts of the insect are no doubt black, the pale parts orange or yellow.

Hab. Mexico, Cuantla, Morelos; from Jassid eggs in cane. (Koebele).

Pentarthron fasciatum sp. nov.

Flavescent, more or less orange in balsam, the apical segments and especially those immediately before the apex of the abdomen blackish, so as to form a wide transverse dark band. Wings clear hyaline, but with a large and conspicuous dark basal area, extending across the wing to the tip of the stigmal vein. In general structure, antennae, etc., this species is like *P. flavum* of Hawaii, but the hairy clothing of the wings is somewhat different. It is not yet certain, whether *P. flavum* is identical with *Trichogramma pretiosa.* In *P. flavum* and *fasciatum* alike, there are six hairlines in the field of the wing from the costa to the line which rises at the apex of the stigmal vein, this line being the sixth. In *P. flavum* between the fourth and fifth hair line there are many additional hairs, in *P. fasciatum*, at most five or six and even only two or three. The hairlines between the one proceeding from the apex of the stigmal vein and the dorsal margin are mostly very clear and distinct in *fasciatum,* whereas in *flavum* there are many irregular hairs between some of the lines. *P. fasciatum* has in all about 13 distinct hair lines on the broad part of the wing toward the apex. The hind wings are smoky basally and have a complete row of discal cilia from the stigmal region to the apex, nearer the costal margin than the dorsal, at least on the apical portion of the wing. Length .5 mm.

Hab. Mexico, Orizaba, Vera Cruz, from eggs of *Diatraea saccharalis,* Dec. 11th, 1907 (Koebele).

MYMARIDAE.

This interesting family, of recent years minutely studied by Girault, has been divided into two subfamilies on the number of joints in the tarsi. I do not attach the same importance to this character as to the condition of the abdomen and thorax and consider that allied form are widely separated by using it. The further subdivisions utilized by Ashmead, whereby the genera with sessile and subsessile abdomen are grouped together is not natural and the subsessile forms should, unless further subdivision is made, be placed with the petiolate ones. If the Mymaridae be treated as a mere family in the Chalcid group, the truly sessile forms make the nearest approach to the Trichogrammidae and Eulophidae (Aphelininae).

I should arrange the groups as follows:

1 (4) Abdomen sessile, with thoracic phragma and muscles continued into the abdomen .... *Alaptidae*
2 (3) Tarsi five-jointed .... *Alaptinae*
3 (2) Tarsi four-jointed .... *Anagrinae*
4 (1) Abdomen subpetiolate or pedicellate, with small attachment to the thorax and without a continuation of the phragma and muscles .... *Mymaridae*
5 (6) Tarsi, five-jointed .... *Ooctoninae*
6 (5) Tarsi, four-jointed .... *Mymarinae*

In many of the species with elongate marginal vein, the apical portion of this vein is free from the costa, and is probably in reality the stigmal vein, which nearly continues the marginal in a straight line.

Gonatocerus.

This genus seems likely to be identical with Section B of *Ooctonus* of Haliday. I have not seen any species of *Ooctonus* that would be placed in his Section A. *Ooctonus australensis* described by me, parasitic in the eggs of *Tettigonia* in Australia, is I think congeneric with *Gonatocerus cingulatus* from the same country and with the American species here described. All these have a distinctly petiolate abdomen, easily seen in dry mounts, but often hard to observe in balsam-mounted examples. The petiole is short and transverse and only slightly longer in my *Ooctonus australensis* than in the others, quite different from that of *Polynema,* which resembles the species of Haliday's section A. In my arrangement of the groups, as given above, *Gonatocerus* and *Ooctonus* would fall in the same group, as is probably natural, whereas in Ashmead's arrangement they are placed in different tribes.

(1) *Gonatocerus rivalis* Girault.

Girault, Tr. American Ent. Soc. XXXVII, 257.

Mr. Koebele bred specimens, agreeing well with Girault's description, from eggs of a Jassid attacking sugar-cane, and I believe that the supposition of the latter, that his *G. rivalis* is the parasite of some water insect will prove erroneous.

Hab. Mexico, Morelos, Cuernavaca, Nov. 23rd, 1907. (Koebele).

(2) *Gonatocerus mexicanus* sp. nov.

Pitchy brown, the abdomen mostly black, the antennae entirely dark, the two basal joints at most a little more pallid; occiput, the parapsidal furrows, and sutures of the mesothorax and base of abdomen paler, more yellowish; trochanters quite pallid, but the femora are notably for the most part dusky; middle and hind coxae yellowish. Described from specimens in balsam, as seen by reflected light. The color is probably darker in examples mounted dry.

The antennae of the female are long and slender, the funicle joints elongate, and differing little in length, the first appears slightly shorter than the second, which is about equal to the pedicel; the eighth funicle joint is slightly shorter than the seventh, which is about two and two-thirds as long as its width at the middle of its length. The club is as long as the eighth, seventh and half of the sixth funicle joints together. In the male the eight or nine apical antennal joints are about equal to the whole length of the insect measured from the front of the head; the pedicel is conspicuously shorter than the first funicle joint, being about two-thirds as long as this, the second funicle joint is also noticeably shorter than the first, the following joints subequal, the antepenultimate antennal joint nearly four times as long as wide. Front wing four times as long as its greatest width, or rather more, the general surface ciliation terminating in a point near the base of the marginal vein, the longest marginal cilia on apical portion of dorsal margin about one-half as long as the greatest width of the wing.

Sheath of ovipositor extended behind the apex of the dorsum of abdomen to a length considerably greater than that of the hind tarsi, or almost equal to the length of the abdomen. Length 1 mm. excl. ovipositor.

Easily distinguished from *G. maga* Gir. by the relative difference in the length of the club, the very long ovipositor, etc.

Hab. Mexico, Chapultepec; bred from Jassid eggs in grass, Nov. 23rd, 1907, No. 2548 (Koebele).

(3) *Gonatoceus koebelei* sp nov.

Black, scape of antennae, all the legs and basal third of abdomen above yellow, pedicel of antennae more or less yellow, but sordid. Front wings with a very distinct large smoky spot occupying most of the apical fourth of their length, but not quite touching the margins. Thorax and abdomen somewhat shining, the former with microscopic reticulate sculpture, the meshes of the reticulation on the scutellum large. Propodeum with a median raised line. (Description thus far from dry specimens).

Antennae of female elongate, 11-jointed, all the joints elongate, the pedicel and second funicle joint about equal in length, but the former much the wider; first funicle joint a little shorter, the club is as long as the three preceding joints of the funicle and on its wide surface is considerably wider than these. The funicle joints differ very little in length, except that the 8th is distinctly shorter than the 7th, the latter being about twice as long as wide.

Antennae of male very long, all the funicle joints very long, and differing very little in length, the first being slightly shorter and also stouter than the second; the antepenultimate joint about three times as long as wide; pedicel distinctly shorter than first funicle joint, but more than half as long as this. Front wings about four times as long as their greatest width, the surface ciliation terminating basally in a pointed manner at the base of the marginal vein, the longest marginal cilia (of the dorsal margin towards the apex) one-third as long as the greatest width of the wing. Lower part of face, thorax and abdomen very sparsely clothed with longish dark hairs. Sheath of ovipositor extending behind apex of dorsum of abdomen for a length about equal to the three basal joints of the hind tarsi, or rather less than half the length of the abdomen. (Description from specimens in balsam). Length 1 mm. or more, excluding ovipositor.

Differs essentially from G.*rivalis* Gir. in that the sixth funicle joint is not small and shorter than the fourth, but is subequal to the fifth and seventh.

Hab. Mexico, Orizaba, Vera Cruz, bred from eggs of Jassid on sugar cane, Dec. 8th, 1907. (Koebele).

(4) *Gonatocerus juvator* sp. nov.

Black (becoming paler in balsam) the basal part of the abdomen and the legs yellow, the front and hind coxae, hind femora widely on the apical portion, and the hind tibiae very conspicuously, black or dark. Scape and pedicel more or less yellowish in part, especially in balsam specimens. Wings noticeably, but lightly and evenly infuscate on their pilose portion.

Antennae of female with the first four funicle joints conspicuously short as compared with the following four; the pedicel is fully as long as the two first together or subequal to the fifth funicle joint. The first, second and third funicle joints are subequal, the second narrower than the others, the fourth is a little longer. The fifth to the eighth are subequal, the sixth not being noticeably shorter than the fifth or seventh; the latter twice as long as wide. Club subequal to the three preceding joints.

Antennae of male with the funicle joints all nearly equally elongate, the antepenultimate antennal joint being three times as long as wide. Front wings with the longest cilia one-third as long as the greatest width of the wing. The line of cilia which leaves the dorsal margin and runs inwardly to this terminates basally at the same point as the fringe of the dorsal margin, and does not meet the line of three or four cilia placed beneath the marginal vein. Consequently somewhat less than the basal half of the wing length is free from the general covering of hairs. Ovipositor not exserted beyond the dorsum of abdomen. Length about 1 mm.

In color this species is somewhat intermediate between *G. brunneus* Gir and its var. *tenuipennis,* the antennal structure being most like the latter. I do not think, however, that it can be considered as a mere race of *G. brunneus.*

Hab. Mexico, Cuantla, Movelos, bred from Fulgorid eggs on sugar-cane Dec. 10th, 1907; No. 2549 (Koebele).

Polynema giraulti sp. nov.

Black, the abdominal pedicel yellow or reddish, the hind coxae also reddish or yellowish brown, the femora and tibiae are darker and infuscate, the apex of the former and base and apex of the latter on all the legs sometimes, but more noticeably on the front pair, being paler; the basal tarsal joint of all the legs pale. Second antennal joint more or less pale. Front wings with an antemedian transverse blackish fascia, and a pair of anteapical blackish spots, one near but not touching the costa, often of roundish shape, the other fainter and opposite this, near, but not touching, the margin opposite. This latter spot varies in size and intensity. Antennae long and slender in the female, the scape with scale-like sculpture of raised lines, in profile the margin appearing serrate, pedicel short and wide, first funicle joint very long, hardly shorter than the second, fourth, fifth and sixth wider than the basal ones and increasing in width, the sixth being long oval or subelliptic, the first joint one and a half times the length of this; club longer than two, but not so long as the three preceding joints. Male with filiform antennae, longer than the whole insect, the joints of the funicle all subequally elongate, parallel-sided, several times as long as wide, excepting the apical joint which is pointed. Front wings with punctiform, black, marginal vein; blunt and with the apical margin even slightly concave, the longest cilia about one-third as long as the greatest width of the wing. Hind tibiae distinctly serrulate, each tooth giving rise to a translucent seta, basal joint of hind tarsi much longer than the three following joints together. Abdominal pedicel in lateral view of equal height throughout. Length about 1 mm.

Hab. Mexico, collected amongst grass in cane-fields. (Koebele).

Polynema eucharis sp. nov.

Yellowish brown or testaceous, transverse frontal ridge black, abdomen darker than the thorax and darker on the more apical segments than on the basal ones, the former being rather dark brown. Legs yellow, tarsi more or less infuscate above. Antennae with the first three joints yellow, the two following less clearly yellow and each with a minute basal black dot, three following dark fuscous or blackish, the large club joint on its wide surface, yellow.

The head and pronotum are sculptured or punctate and bear a white pubescence; the pronotum is long; the rest of the thorax very smooth and shining, impunctate or nearly, the parapsidal furrows distinct. Abdominal pedicel very elongate, fully as long or a trifle longer than the hind femora and concolorous with these, rather narrower near the apex than at the middle, many times as long as wide, the rest of the abdomen smooth and shining, narrow, elongate-ovate. Ovopisitor slightly exserted (in dry specimen).

Front wings rather more than three times as long as the greatest width, very slender on more than the basal third, so that the width at the base of the submedian fascia is not one-third the greatest width of the wing, the apical margin blunt and wide, their color white, the marginal vein nearly black, and with a slight infuscation beneath it, a very conspicuous dark fuscous, wide, submedian, transverse fascia, an equally conspicuous but narrower anteapical one, the basal margin of which is angulately indented about the middle and the apical side is angulately produced opposite the indentation; on the dorsal side the fascia is bilobed, so as to include a large white spot. Longest marginal cilia (near apex of dorsal margin) about one-third as long as the wing-width. Clothing of dark hairs regular over the wing surface and continued basally to beneath the marginal vein. Hind wings with numerous discal hairs; a dark band beneath the marginal vein and a second one occupying half the space between the former and the apex of the wing, but the apex of the wing itself is clear for some distance.

Antennae of female long, slender, scape short, wide, only about twice as long (including its basal pedicel) as its greatest width; distinctly shorter than the first funicle joint; pedicel about half as long as the first funicle joint, which is only about half the length of the second, the third about one-fourth longer than the second; fourth much shorter, between one-half and two-thirds the length of the third, or about three-fourths the length of the second; fifth a very little shorter than the fourth, but stouter; sixth very conspicuously stouter than the fifth, and about five-sixths its length; the fifth funicle joint is about seven times as long as its width at the middle, the apex being somewhat more dilated. Club very large, nearly two and a half times as long as the width at the middle of its length, subequal in length to the two preceding funicle joints. Length about 1.5 mm. The antenna is described from balsam specimen, rest of the insect from dry mount.

Hab. Fiji, Suva (Muir).

Eomymar gen. nov.

Head transverse, ocelli in a very wide triangle, each of the outer ones about three times as far from the anterior ocellus as from the eye-margin. Antennae of the female 10-jointed, all the funicle joints very elongate, club-joint long and large, about equal to three preceding joints together; antennae of male 11-jointed. Pronotum extremely short, not or hardly visible in dorsal aspect. Tarsi 5-jointed. Front wings very narrow, dilated beneath the marginal vein on the dorsum, where they are widest, beyond this (apically) the dorsal margin is conspicuously sinuate; marginal cilia extremely long. Marginal vein long, continued into an elongate stigmal, which is consequently very oblique, and is bent towards the costa at its extremity; a submedian row of longish erect bristles, extending far back from the tip of the wing but not reaching the region of the neuration. First abdominal segment forming a short but distinct petiole, the abdomen behind this ovate, pointed at the apex, triangular in outline, with rounded base. Ovipositor not evidently exserted.

Eomymar muiri sp. nov.

Black or dark brown (becoming lighter in balsam) shining, legs yellow, scape and pedicel of antennae more or less yellow, or at least paler than the funicle (sometimes quite yellow in balsam).

Scape in the female widest (on its flat face) near the middle, where it is obtusely angulated, the pedicel obconic, evidently longer than wide, shorter by one-third to one-half its length than the very elongate first funicle joint, which is slightly longer than the second. Three, four and five subequal, but the last of these is conspicuously wider than the fourth, the sixth still stouter, the seventh wider still, about twice as long as wide, hardly shorter than the preceding, though appearing so, owing to its greater width. Club subequal to the three preceding joints together. Antennae of male very long and slender, pedicel much shorter than the first of the funicle joints, these all very elongate and mostly not differing much in length, the first distinctly widened on its basal part, the seventh funicle joint about four times as long as its greatest width, or rather less.

Front wings about 12 or 15 times as long as the width beyond the middle; a row of bristles on the apical part of the wing along each margin, the bristles originating close to, and alternating with, the long marginal setae; another row is placed close to and just inwardly to each of these, while in the well developed submedian row the bristles are more or less irregularly placed in the series. Sheaths of ovipositor at most very slightly protruded beyond the dorsal extremity of the abdomen. Length about .5 mm.

Hab. Java, Pekalongan, bred from eggs of Delphacid, probably *P. vastatrix.*

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UNCATALOGUED

ENTOMOLOGICAL SERIES

BULLETIN No.

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

PARASITES OF THE FAMILY *DRYINIDAE.*

BY R. C. L. PERKINS

HONOLULU, HAWAII.
SEPTEMBER 20, 1912.

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EMTOMOLOGICAL SERIES. BULLETIN No. 11

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

PARASITES OF THE FAMILY *DRYINIDAE.*

BY R. C. L. PERKINS

HONOLULU, HAWAII.
1912.

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the Hawaiian
Sugar Planters' Association,
Honolulu, Hawaii.

Dear Sirs:

I herewith submit for publication as Bulletin No. 11 of the Entomological Series, an article by Dr. R. C. L. Perkins, Entomologist, entitled: "Parasites of the Family *Dryinidae*."

Yours very truly,

C. F. ECKART,
Director.

Honolulu, April 13, 1912.

PARASITES OF THF FAMILY *DRYINIDAE.*

By R. C. L. PERKINS.

In Bulletin I (p. 3-69 and p. 483-499) and Bulletin IV (p. 5-55) an account was given of the interesting parasites of the family *Dryinidae*. A number of figures was prepared by Mr. W. E. Chambers to illustrate these Bulletins, but as they were not completed until long after the letter press, they have never been published. I have, therefore, completed the working out of the material at present available and added some further general remarks, in order that the former bulletins may be rendered more complete, and that these excellent plates may now be published.

In 1907 a classification of the *Dryinidac* by Dr. J. J. Kieffer was published in "Wytsman's Genera Insectorum," wherein the family was divided into three subfamilies, *Dryininae, Gonatopodinae,* and *Anteoninae.*

The characteristics there given for the separation of the subfamily *Dryininae* are based on the shape of the stigma of the front wings, which is narrow or lanceolate, and on the fact that the hind angles of the pronotum do not reach back to the tegulae. In the males of the *Dryininae,* however, as in all *Dryinidae,* the prothoracic angles reach the tegulae, and I suspect that this is the case in some females assigned to the subfamily, e. g., *Bocchus* and *Chelothelius*, though I have seen no specimens of either genus, unless my *Eukoebelcia* be synonymous with the former. *Phorbas* Ashm. must certainly have the pronotal angles and tegulae meeting together. As to the form of the stigma, some genera have this in a condition more or less intermediate between the narrow, lanceolate-shaped ones and the large oval. This is the case with *Chelothelius* and the females of *Deinodryinus,* the former of which should, I think, be removed from Kieffer's Dryininae and placed in his Anteoninae, where *Deinodryinus* belongs, as is clearly proved by its male, which has a larger stigma and a form of antennae characteristic of the Anteon group. *Chelothelius* is probably parasitic on one of the *Jassoidea* (as evidenced by the structure of its chelae), a habit at present unknown in the winged *Dryinini.*

The small group *Emboleminae* of Ashmead should be placed as a subfamily of *Dryinidae.* Although the nervures of the wings in *Dryininae* and *Aphelopinae* are often for a large part effaced and colorless, their position can easily be made out. A comparison of the figures of such diverse genera as *Labeo, Embolemus* and *Aphelopus,* as drawn by Haliday (Ent. Mag. IV, Pl. XVI, Art. LIII), those of Ashmead (Mon. Proct.), of Brues (J. New York Ent. Soc. XVIII, p. 15), and those given in this Bulletin, show the complete identity of the neuration throughout the *Dryinidae.* In some species of *Aphelopus,* where the distinct neuration is most reduced, even the line indicating the transverse cubitus is easily seen.

As I have previously stated, I consider the genus *Gonatopus s. l.* to be made up of groups entirely distinct phylogenetically, and the description of the remarkable Gonatopus-like creature, *Dryinopsis simplicipes* Brues, with 12-jointed antennae and simple front tarsi, confirms me in this opinion.

Little is known at present of the habits of the *Emboleminae,* but my Australian genus *Harpagocryptus* was bred from *Orthoptera* (Grylloids) and as similar, but quite distinct, larvae of *Dryinidae* have been found on very different *Orthoptera* in other parts of the world, it is possible that most, if not all, of the members of the *Emboleminae* are parasites on *Orthoptera.* It is interesting to note that the elongate larval sac of *Harpagocryptus* and *Aphelopus,* so different from those of all other *Dryinidae,* is correlated with the possession of simple front tarsi in the females. I have tabulated the few known genera of *Emboleminae* (so far as the females are concerned), but have omitted *Pedinomma,* the position of which is quite doubtful. *Algoa* of Brues must be extremely close to my *Harpagocryptus.* The condition of the labial palpi I consider to be of great importance in the wingless *Dryininae* of the Gonatopiform series, and consequently members of this series fall into different tribes.

It is clear that the classification of the *Dryinidae* must at present be based chiefly on the female structure, though the males, where known, are useful, as affording a clue to affinities. Of many species of *Gonatopus s. l.* males are very rarely obtained by breeding, so that many hundreds of the females may be raised without a single male appearing. Some, however, produce males more or less freely, while of some no males have yet been obtained. In America Mr. Koebele bred and captured many examples of various species of *Eugonatopus* and *Agonatopus,* but not a single male was disclosed.

TABLE OF GROUPS OF *DRYINIDAE.*

1. (12) Front tarsi of both sexes simple not chelate.
2. (11) Wingless or subapterous, or if winged with median submedian and discoidal cells distinct, stigma small or narrow; labial palpi 3- or 4-jointed, antennae with 12 or 13 joints........*Emboleminae*
Females:
3. (6) Antennae 13-jointed.
4. (5) Fully winged .... *Embolemus* West.
5. (4) Wings rudimentary .... *Olixon* Cam.
6. (3) Antennae 12-jointed.
7. (8) Thorax as in *Gonatopus,* with a median stalk.... .... *Dryinopsis* Brues
8. (7) Mesonotum small, but not forming a narrow stalk,
9. (10) Apterous .... *Algoa* Brues
10. (9) With rudimentary wings ...... *Harpagocryptus* Perk.
11. (2) Winged, with large ovate or subtrigonal stigma, only the subcostal and radial nervures well defined; antennae 10-jointed, labial palpi 2-jointed. .... *Aphelopinae*
12. (1) Front tarsi of females chelate, antennae always 10-jointed .... *Dryininae*
13. (14) Stigma large, ovate, chelae rarely fully extensile front trochanters small, not elongated but almost like those of the other legs, (labial palpi 3-jointed), chelar claw always without denticles...... ....*Anteonini*
14. (13) Stigma narrow or lanceolate; front trochanters always different from the others, being elongate, and often very long, chelae perfectly extensile, chelar claw in many genera with lamellate denticles; apterous species very numerous.
15. (16) Labial palpi 3-jointed .... *Dryinini*
16. (15) Labial palpi 2-jointed .... *Gonatopodini*

The males of the *Emboleminae* are little known, but in two of the genera they resemble the *Dryininae* in venation and in having only ten joints to the antennae. In the other groups they are distinguished as follows:

Subcostal and radial veins distinct, but no median, submedian or discoidal cells clearly defined; labial palpi 2-jointed, stigma very large .... *Aphelopinae*

Basal cells generally and frequently discoidal cells distinct or if the basal cells are defined only by hyaline nervures the the stigma is narrow or lanceolate .... *Dryininae*

Stigma large and more or less ovate (labial palpi 3-jointed) .... *Anteonini*

Stigma narrow or lanceolate, labial palpi 2- or 3-jointed.

Labial palpi 3-jointed; head never so strongly excavated posteriorly .... *Dryinini*

Labial palpi 2-jointed; head always deeply emarginate posteriorly .... *Gonatopodini*

The males of the *Anteonini* are further generally easily separated by the rather different nature of the insertion of the scape of the antennae on its basal pedicel. The males of *Dryinini* and *Gonatopodini* are sometimes extremely similar, so that males of *Dryinus* and *Gonatopus* have been described by Ashmead under one Genus *Labeo.* This latter genus was characterized by Haliday as having short palpi, the maxillary three-jointed. I have males of *Gonatopus s. l.* with these characteristics, but *Labeo* of Kieffer is placed in his table under genera with "palpes maxillaires longs" and "palpes maxillaires de cinq articles." He remarks further that I state that the male of *Gonatopus s. l.* (i. e. *Labeo s. l.*) has bare eyes, but I find no such statement of mine, and have always known the eyes to be conspicuously hairy. As to *Chalcogonatopus,* I have discriminated this by its longer palpi, the labials being three-jointed, whereas the males of *Gonatopus* s. l. in Bulletin I (p. 22 and p. 33) are shown to have shorter palpi and the labials only two-jointed. Consequently the foot-note in Kieffer's work, p. 13, should be deleted. The male of *Chalcogonatopus* was not described at length because it could not be with certainty referred either to *C. optabilis* or *C decoratus* (though doubtless belonging to one of these), and I did not care to give it a name, destined to become a synonym.

The structure of the thorax of the *Dryinidae* has been misunderstood both by Ashmead and Kieffer. Thus the latter, in referring to the *Dryininae*, in which the posterior pronotal angles do not reach to the tegulae, remarks that "les propleures les atteignent." The prothoracic pleura, however, are far removed from the tegulae and contribute largely to a lengthening of the prothorax anteriorly, while the space between the hind angle of the pronotum and the tegulae is occupied by the anterior part of the mesopleura, almost exactly as in some *Sphegidae*. In his figures showing the structure of *Gonatopus,* Kieffer, as did Ashmead in his descriptions, mistakes the hind lobe of the pronotum, when this sclerite is divided by a transverse furrow, for a part of the mesonotum. But the latter is formed in front solely by a narrow stalk, easily separable from the pronotum, which is movable upon it, and posteriorly a small scutellum is sometimes defined, articulating with the propodeum (or fused metathoracic and first abdominal segment) and also separable at the articulation. As a matter of fact, the large pronotum of *Gonatopus* is almost identical in structure with that of some winged forms, and its development is correlated with the great development in length of the front legs. It is interesting to note that in the winged *Dryinini* the mesonotum, though wide for the most part, is anteriorly narrowed into a small neck fitting into the pronotum, which is movable upon it. In some genera the parapsidal furrows extend back from this neck, and if the parts of the mesonotum exterior to the furrows be left out, a thorax extremely similar to that of *Gonatopus* results. But in full-winged forms, as is natural, no such reduction of the mesonotum ever takes place.

The close alliance of the tribes that I have recognized in the *Dryininae* is shown by the extreme resemblance of males of such forms as *Neodryinus* to those of some *Gonatopus s. l.;* and *Eukoebeleia* makes a great approach in some respects to the Anteonini. In making these studies I have critically examined about seventy species of *Gonatopus s. l.* and about fifty species of winged forms, in addition to a large number of European forms, winged and wingless. The greater number of these having been bred, I would specially refer to two points: (1) The variability of some species in color or sculpture, or both; (2) the importance of the form and armature of the claw of the chelae, which in the Gonatopiform species at once enables the parasite to be determined as to whether it attacks a Jassoid or Fulgoroid Homopteron. All the literature known to me on these insects has also been examined.

The arrangement of genera described in the Bulletins of this Station is as follows:

APHELOPINAE.

Aphelopus.

DRYININAE.

Anteonini.

Anteon, Paranteon, Chelogynus, Deinodryinus.

Dryinini.

Neodryinus, Paradryinus, Hesperodryinus, Chlorodryinus, Perodryinus, Thaumatodryinus, Eukoebeleia, Apterodryinus, Eucamptonyx, Agonatopoides, Chalcogonatopus, Agonatopus.

Gonatopodini.

Echthrodelphax, Gonatopus, Dicondylus (Gonatopus m.), Pachygonatopus, Epigonatopus, Pseudogonatopus, Paragonatopus, Haplogonatopus.

In my table of genera (Bull. IV, p. 9) the following corrections should be made:

4. (7) Labial palpi 3-jointed.
5. (6) Maxillary palpi 6-jointed.
a. (b) Chelar claw normal, with minute ante-apical tooth. .... *Apterodryinus*
b. (a) Chelar claw strongly bent on the apical portion..... .... *Eucamptonyx*
6. (5) Maxillary palpi 5-jointed .... *Agonatopoides*
10. (11) Pronotum divided by a transverse impression..... .... *Paragonatopus*
11. (10) Pronotum not so divided .... *Haplogonatopus*

On page 40 (seventh line from the bottom), for "fourth" read "fifth."

DRYININI

Paradryinus terryi sp. nov.

Black, the apex and sides of clypeus, the scape of the antennae, their three apical joints and most of the one preceding these, pale yellowish. Front coxae yellowish brown, dark at the sides, the tips whitish, trochanters dark at the base, red apically. Front femora red above, and beneath dark at the sides, tibiae pale above. Middle and hind coxae and femora dark reddish, the tibiae dull blackish; metatarsi more or less infuscate, the more apical joints testaceous; apex of abdomen more or less pale. Wings with only two dark fasciae, the narrow middle one being confluent below with the basal one, the submedian cell being entirely dark on its apical portion, the median cell clear at the apex.

Head dull, longitudinally rugose and with minute surface sculpture; third antennal joint about twice as long as the fourth, the latter and the fifth notably widened, the following ones being considerably thinner. Pronotum longitudinally rugose, very finely so on the disc, more strongly at the sides, and in front with a lateral smooth, polished area. Mesonotum very dull, with extremely fine sculpture medially between the parapsidal furrows, which are distinct, and much more roughly sculptured outside these. Propodeum above with regular longitudinal wrinkles, posteriorly and laterally strongly reticulate. Abdomen black or nearly so, not red basally, very smooth and shining. Length 8 mm.

Somewhat resembles *P. gigas,* but very distinct by the color of the wings, antennae and abdomen, and the quite different mesonotal sculpture.

Hab. China, Hong Kong; a single example collected by the late Mr. F. W. Terry.

Paradryinus javanus sp. nov.

Black, the face below the antennae pale, the scape and second joint of the antennae in front yellow, the following joints brownish or brownish testaceous, the apical joint clear testaceous. Legs brown or testaceous, the hind and middle tarsi pallid, paler than the tibiae. Pronotum rufescent along the hind-margin and at the sides, the anterior margin very narrowly pale. Wings with the usual three transverse fasciae distinct, the basal one being well separated from the narrow median one by the hyaline apical portions of the median and submedian cells.

Head dull, densely sculptured and with some fine longitudinal wrinkles. Pronotum with dense, fine sculpture, mesonotum dull with dense sculpture, distinctly smoother and sometimes a little shining in the middle between the fine parapsidal furrows.

Propodeum reticulately rugose. Basal joint of front tarsus distinctly longer than the fourth. Abdomen very smooth and shining, the apex rufescent. Length 3-4 mm.

Judging from the three specimens that I have seen, this species varies somewhat in sculpture and in the color of the antennae and legs, the smallest example having the antennae of a testaceous yellow and very little darkened. It is closely allied to the Australian *P. leptias,* but that is easily known by the four pallid apical joints of the antennae strongly contrasted with the dark preceding ones, the less distinct separation of the basal and median fasciae of the wings, and the very dark femora and tibiae of all the legs, while the middle and hind tarsi are also fuscous above.

Hab. Java, Pekalongan (Muir); bred from nymphs of *Thanatodictya* (No. 317, 367 and 295).

GONATOPODINI

Pseudogonatopus nudus sp. nov.

Face, mandibles, and two basal antennal joints pale yellowish, head above and the thorax bright brown, the mesonotal constriction evidently paler or yellowish, femora more or less sordid brown, the hind and middle tibiae and tarsi and all the trochanters more pallid. Abdomen with the petiole black, a ferruginous area behind this, the rest nearly black.

Head above concave, somewhat shining; antennae moderately long and slender, third joint thin and very much longer than the fourth, the apical joint dark. Pronotum with distinct transverse furrow, shining, very feebly sculptured and without hairs, mesonotal constriction dull, with very dense microscopic surface sculpture; propodeum smooth and shining on the disc, posteriorly at the sides very feebly transversely rugulose, the wrinkles less definite in the middle, without erect hairs. Abdomen glabrous and polished. First and fourth tarsal joints of front legs subequal, the claw with about six well developed lamellate denticles. Length 2.75 mm.

Hab. Java, Pekalongan (Muir); bred from a *Dicranotropis* (No. 349); larval sac nearly uniform dark fuscous, placed near the base of the abdomen of the leaf-hopper.

Pseudogonatopus hospes sp. nov.

Black, the face below the antennae and two basal joints of these pale, the pale color of the face continued above the antennae in the middle line and along the inner orbits. Front, middle and hind coxae dark above, pale beneath and at the apex, front trochanters more or less brown above on the thickened portion, tibiae testaceous, the front ones darkened in front and behind, tarsi testaceous; apex of abdomen pale; the hind femora have a paler area between the darkened base and apical portion, while the front ones except at the extreme apex are nearly uniformly dark brown.

Head strongly concave between the eyes, minutely microscopically sculptured, so as to be not much shining; antennae longish and slender, the third joint one and two-thirds the length of the fourth, or rather longer still, black the extreme base only pale, the fourth hardly wider than it. Pronotum very distinctly divided, with dense surface sculpture, appearing punctate under a strong lens, mesonotal constriction with similar dense sculpture, behind which the propodeum in front of the spiracles is transversely rugose, as also on its posterior surface, while between these areas it is sculptured much like the pronotum. The whole thorax is without any erect pubescence. Front coxae very long, three times as long as high, the trochanters with long thin basal stalk,. the chelae normal for the genus, the claw bearing about eight or ten well developed lamellate denticles, the anteapical marginal tooth of the lower side distinct. Abdomen with minute, but distinct, microscopic sculpture, so that it is not highly polished, almost without pubescence, the apical margins of the segments generally more or less paler. Length 4 mm.

Hab. Java, Pekalongan, and China (Muir). This species was established in the islands from cocoons sent from China.

Paragonatopus nigricans P.

To this genus and species must be referred the unique specimen described as *Pseudogonatopus melanacrias*. Mr. Muir has taken this in Fiji, the original locality, and I have dissected out and examined the palpi. It varies in color, the usually black propodeum being sometimes red on the disc, while one example, which appears specifically identical, has the whole thorax of a bright ferruginous yellow.

GONATOPUS.

According to Kieffer this genus has four-jointed maxillary palpi and is therefore the same as my *Neogonatopus*, while the species of *Gonatopus* previously described by me should be referred to *Dicondylus* Hal.

Gonatopus anomala sp. nov.

Face pale, the mandibles and front of scape, yellow, the head above dark brown, two basal joints of antennae pale, third infuscate, the rest dark fuscous or black. Thorax brown, the propodeum of darker shade than the pronotum, tarsi pale testaceous, the femora and middle and hind tibiae darker, sordid. Abdomen blackish, paler basally behind the petiole.

Head above shining and concave between the eyes, the antennae with the third joint one and a half times as long as the fourth, or more. Pronotum with some sparse erect hairs, feebly sculptured, in side view simply convex above, the transverse division being absent. Propodeum with very sparse, but distinct, erect, longish hairs, shining above both in front of and behind the spiracles, its posterior face distinctly transversely rugose. All the femora with distinct, erect, pale hairs, first and fourth joints of front tarsi subequal, chelae normal for Jassid parasites. Abdomen polished, clothed sparsely with distinct pale hairs. Length 3 mm.

This species is remarkable for the simple pronotum and is doubtfully placed under the genus *Gonatopus*. The maxillary palpi are very short, and perhaps there is only one joint beyond the flexure.

Hab. Fiji, bred from Jassid (Muir).

Dicondylus perpolitus sp. nov.

Deep black, for the most part highly polished. Face below the antennae, and for a short way above these along the eye margins, and the mandibles, pale. First three antennal joints testaceous or the third more or less dark. All the coxae black or nearly so and clothed with sparse pale hairs, the trochanters and tibiae paler, the tarsi quite pale testaceous.

Head above with excessively minute microscopic reticulation, which does not prevent it from being shining, the vertex with sparse, short, white hairs.

Antennae moderately stout, the thin third joint about one and a half times as long as the fourth. Pronotum with well marked transverse division, very highly polished, the hind lobe with fine indefinite punctuation; mesonotal constriction rugulose, the thorax behind the constriction with evident pale hairs beneath and at the sides, but above almost glabrous, posteriorly finely transversely rugose, on the disc highly polished. Femora with short, inconspicuous, pale hairs. Basal joint of front tarsi about equal to the fourth joint, thin basal portion of front trochanters short, chelae normal for Jassid parasites. Abdomen very smooth and shining, with a few short and inconspicuous hairs. Length 3 mm.

Hab. Java, Pekalongan (Muir).

Dicondylus plebeius sp. nov.

Brown or ferruginous, the head above generally darker brown, the abdomen black, but with a ferruginous spot behind the pedicel; mandibles (more or less) and front of scape yellow, second and usually more or less of the third joint of antennae testaceous, the following joints black. Pronotum and other parts of the thorax sometimes with darker markings. Front femora and sometimes the tibiae more or less darkened, the apices of the former pallid. Mesonotal constriction evidently paler than the adjoining parts of the thorax.

Head above concave, usually not highly polished, though more or less shining, clothed with erect hairs posteriorly. Third joint of antennae about one and a half times as long as the fourth, the latter considerably stouter. Pronotum and disc of the propodeum highly polished, the mesonotal constriction dull, the thorax bearing scanty erect hairs; the propodeum posteriorly very finely transversely rugulose.

First and fourth joints of anterior tarsi subequal, chelae of the usual type in Jassid parasites. All the femora with distinct clothing of sparse erect hairs. Abdomen shining, sparsely clothed with distinct erect hairs. Length 3 mm.

Closely allied to *Gonatopus australiae*, but distinguished by the ferruginous propodeum with shorter hairs, and the distinct abdominal pubescence, which is not confined to the base.

Hab. Java, Pekalongan (Muir); bred from nymph of Jassid; larval sac dull black, placed ventrally on the abdomen of the leafhopper.

Dicondylus javanus sp. nov.

Black, the face below the antennae, and the scape in front yellow, the following antennal joints testaceous, the three or four apical ones dark fuscous or black: trochanters, tibiae and tarsi of all the legs pale, the front tibiae browner outwardly, the trochanters sometimes marked with brown, apex of hind tibiae darkened, the tip of all the femora pale.

Head above strongly concave, very minutely and closely sculptured, so that it is not very shining, with a distinct fine median raised line. Third antennal joint long and slender, one and a half times the length of the fourth or rather more, fourth distinctly longer than the fifth, eighth about two and a half or three times as long as wide. Pronotum transversely grooved before the middle, densely minutely sculptured, much more strongly than the head; behind the transverse groove dull or nearly so, as is the mesonotum and the propodeum, the latter finely transversely rugulose posteriorly and also on the part in front of the stigmata, without erect hairs on its dorsal surface. Front tarsi with the fourth joint very little shorter than the first, fifth beneath with two rows of lamellate denticles on the apical part of its thickened portion and the apical curved part also armed with denticles; claw with a few fine hairs beneath, as usual in Jassid parasites. Legs without erect pubescence. Abdomen very smooth and shining with a very few short appressed hairs, the extreme apex more or less red. Length 3-3.5 mm.

Hab. Java, Pekalongan (Muir); bred from *Deltocephalus;* larval sac abdominal on mature leaf-hoppers, dark fuscous, dull and densely sculptured, or minutely shagreened, more or less variegated with pallid color.

ANTEONINI

Chelogynus cognatus P.

This species is synonymous with *Prosanteon chelogynoides* (*op. cit p.* 66).

The chelae being obscured with gum in the single carded specimen, I misunderstood the true nature of the front tarsi, until recently, when these were cleaned. This example differs a little in color from the type of *P. chelogynoides* and was bred from a different genus of Jassidae, but the differences seem too small to be of specific value.

CHALCIDOIDEA

ENCYRTIDAE

Echthrogonatopus hawaiiensis sp. nov.

Metallic green, the abdomen except at the base, the pleura and propodeum purple. Front and middle tarsi, apical joints of the hind tarsi and apex of middle tibiae yellow. Apex of middle and sometimes of front femora and extreme base of their tibiae also more or less pale. Antennae entirely dark. Front wings blackish fuscous from near the base of the marginal vein to the apex, the dark part including a large hyaline costal spot, originating (on the basal side) at the apex of the post-marginal vein and extending longitudinally nearly half the distance from this vein to the tip of the wing, but transversely not reaching its middle; opposite this on the dorsum is an elongate hyaline area. At the extreme base the wing is again dark. A distinct bare line runs obliquely from beneath the marginal vein in the dark portion of the wing to become lost in an extensive bare area in the hyaline portion.

Head dull, with minute surface sculpture, and a single row of shallow punctures on each side bordering the inner margin of the eyes. Antennae with the second, third and fourth joints small transverse, fifth and sixth distinctly larger and also transverse, club nearly as long as the funicle. Mesonotum shining, with excessively fine microscopic surface sculpture, and a few feeble punctures, thinly clothed with pale hairs; scutellum similarly clothed, darker and duller than the mesonotum; pleura shining. Abdomen with the usual group of long setae on each side towards the base, which is very shining. Length 1.5 mm.

Allied to *E. exitiosus* of Australia, but very distinct. The hairs on the eyes are very indistinct, if not altogether absent.

Hab. Hawaiian islands, Oahu; parasitic on *Pseudogonatopus perkinsi.*

Cheiloneurus javanus sp. nov.

Face, scutellum, the axillae, propodeum, pleura, and the middle of the abdomen yellow and in parts whitish yellow; head above sordid, the pronotum and mesonotum dark fuscous, submetallic in some aspects, head behind the eyes and cheeks distinctly metallic, base and tip of abdomen dark, the former brightly metallic. Antennae pale yellow or whitish, with black club. Wings hyaline at the base, infuscate from the base of the marginal vein apically, but the dark part with a hyaline margin of irregular width extending round from the region of the post-marginal vein to the dorsum opposite this vein. The infuscation itself is darker in some parts than others. Legs pale, the hind femora generally a little darkened at the apex.

Ocelli in an isoceles triangle, of which the sides are about twice the length of the base, the surface of the head between the eyes dull, densely microscopically sculptured. Mesonotum densely clothed with silvery short pubescence; scutellum sparsely clothed and with the usual tuft of erect black hairs; mesopleura dull. Abdomen shining metallic at the base. Length 1 mm.

Hab. Java, Pekalongan (Muir); parasitic on *Paradryinus*. (No. 352).

Obs.—In my description of *C. gonatopodis* (Bull I, p. 261, line 14), for "basal half" read "apical half."

EXPLANATION OF PLATES.

PLATE I.

1. *Gonatopus haplothorax,* female (Bull. Ent. H. S. P. A. Exp. Station IV, p. 35).
2. *Agonatopus synchromus,* female (Bull. IV, p. 33).
3. *Haplogonatopus apicalis* (?), male (Bull. I, p. 39).
4. *Haplogonatopus americanus,* female (Bull. I, p. 40).
5. *Agonatopus ferrugineus,* female (Bull. IV, p. 30).

PLATE II.

1. *Paradryinus venator,* female (Bull. I, p. 55).
2. *Neodryinus koebelei,* male (Bull. I, p. 51).
3. *Echthrodelphax bifasciatus,* female (Bull. I, p. 49).
4. *Paradryinus venator,* male (Bull. I, p. 55).
5. *Neodryinus koebelei,* female (Bull. I, p. 51).

PLATE III.

1. *Hesperodryinus arizonicus,* male (Bull. IV, p. 42).
2. *Chlorodryinus pallidus,* male, (Bull. I, p. 57).
3. *Chlorodryinus pallidus,* female (Bull. I, p. 58).
4. *Hesperodryinus amphiscepae,* female (Bull. IV, p. 41).
5. *Echthrodelphax fairchildii,* female (Bull. I, p. 49).

PLATE IV.

1. *Chalcogonatopus leptias,* female (Bull. IV, p. 17).
2. *Paranteon myrmecophilus,* female (Bull. IV, p. 46).
3. *Deinodryinus paradoxus,* female (Bull. IV, p. 46).
4. *Chelogynus typicus,* female (Bull. I, p. 61).
5. *Apterodryinus torvus,* female (Bull. IV, p. 14).

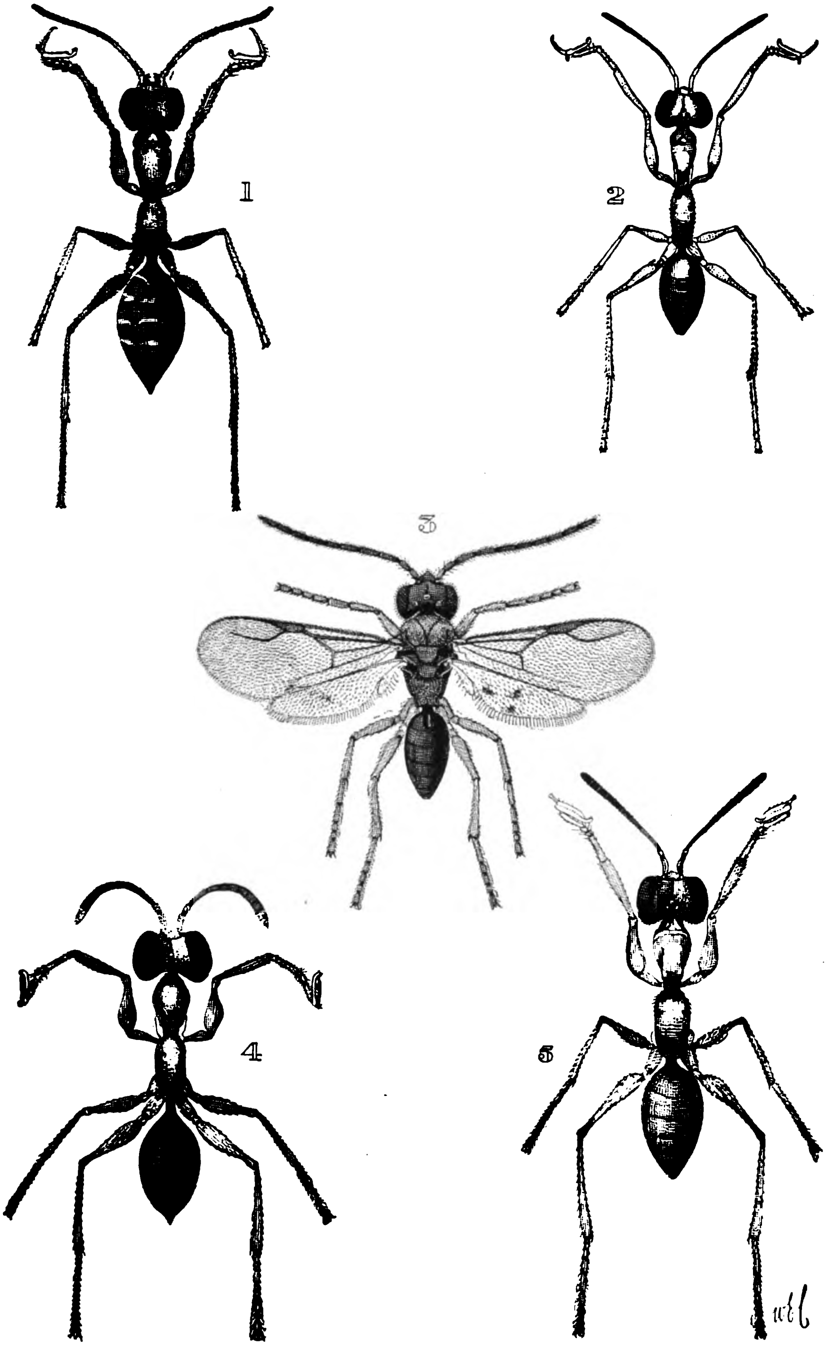

PLATE I.

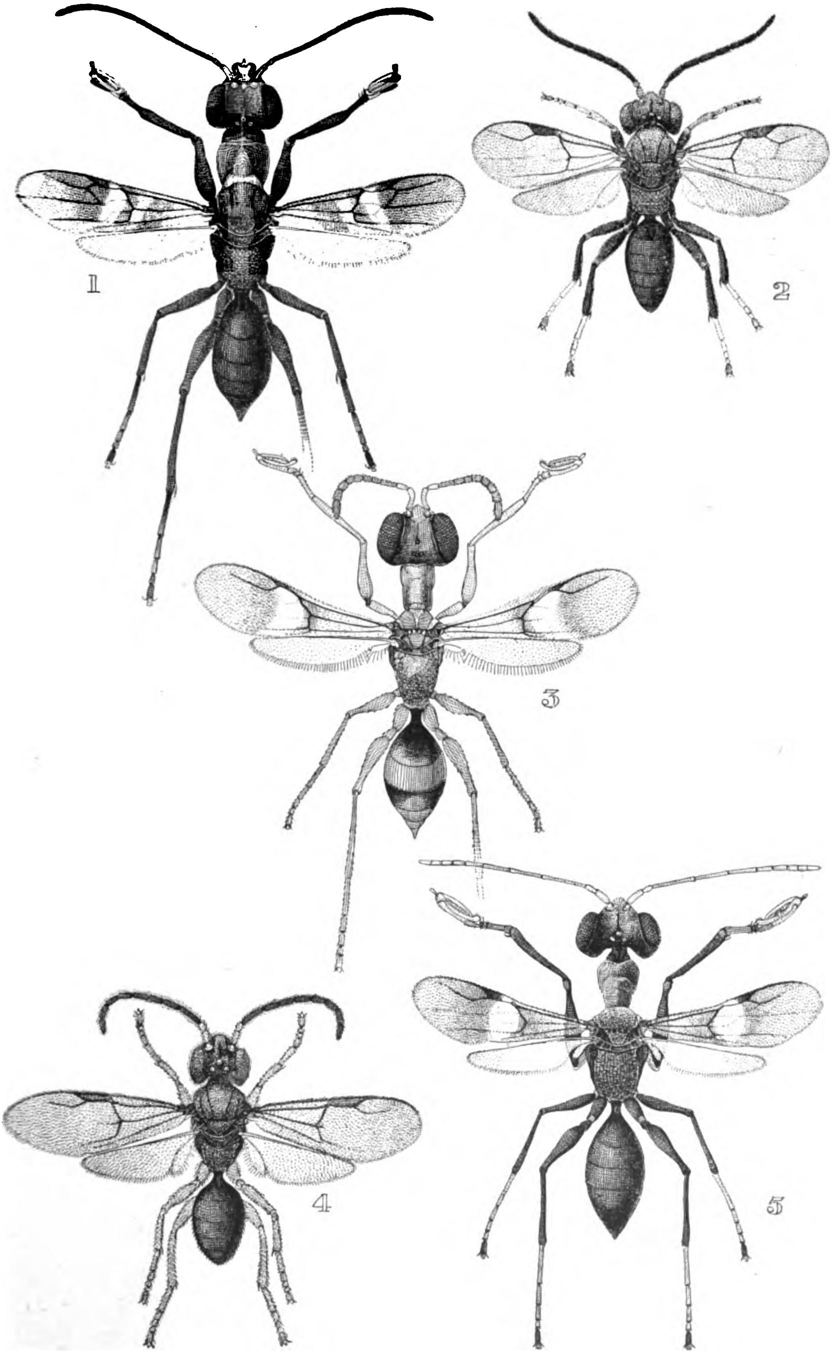

PLATE II.

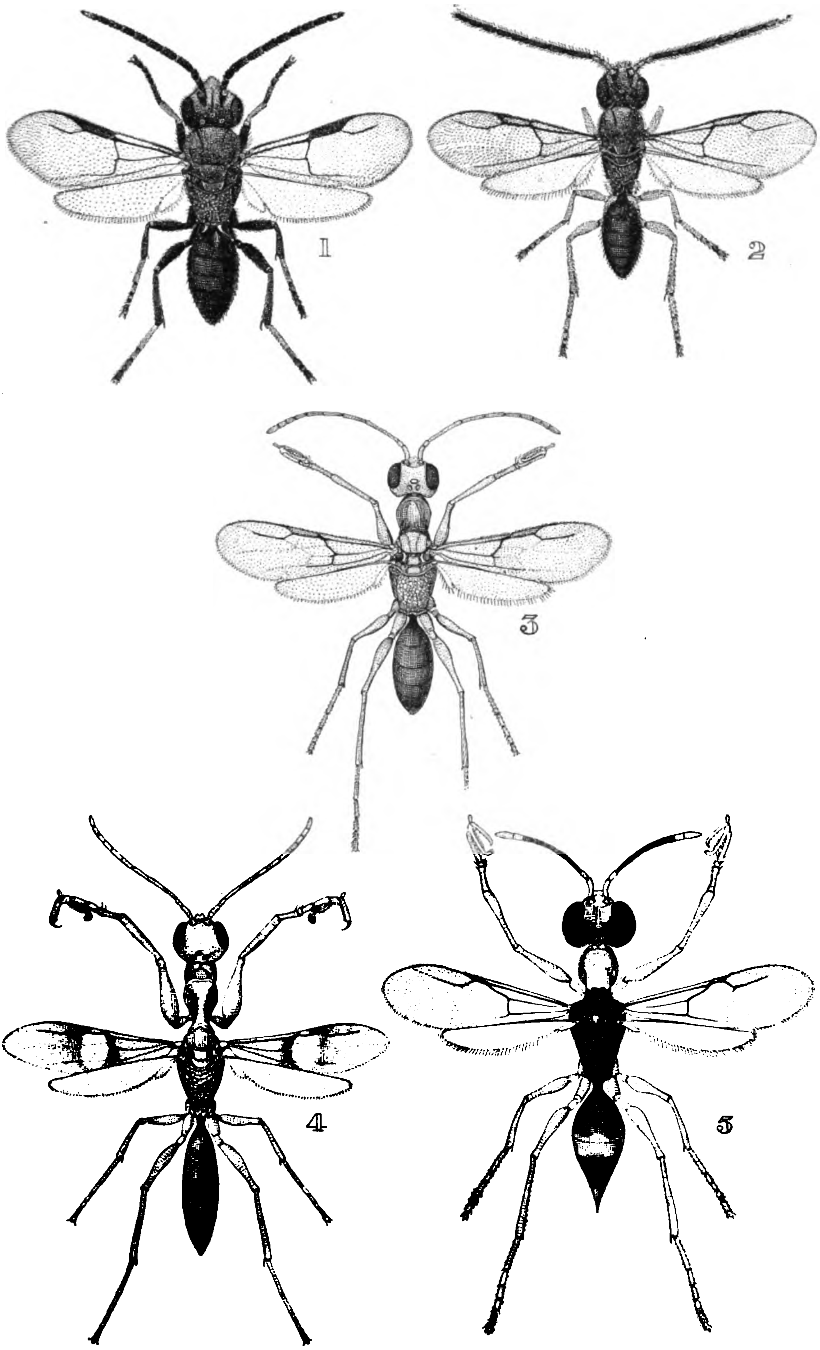

Plate III.

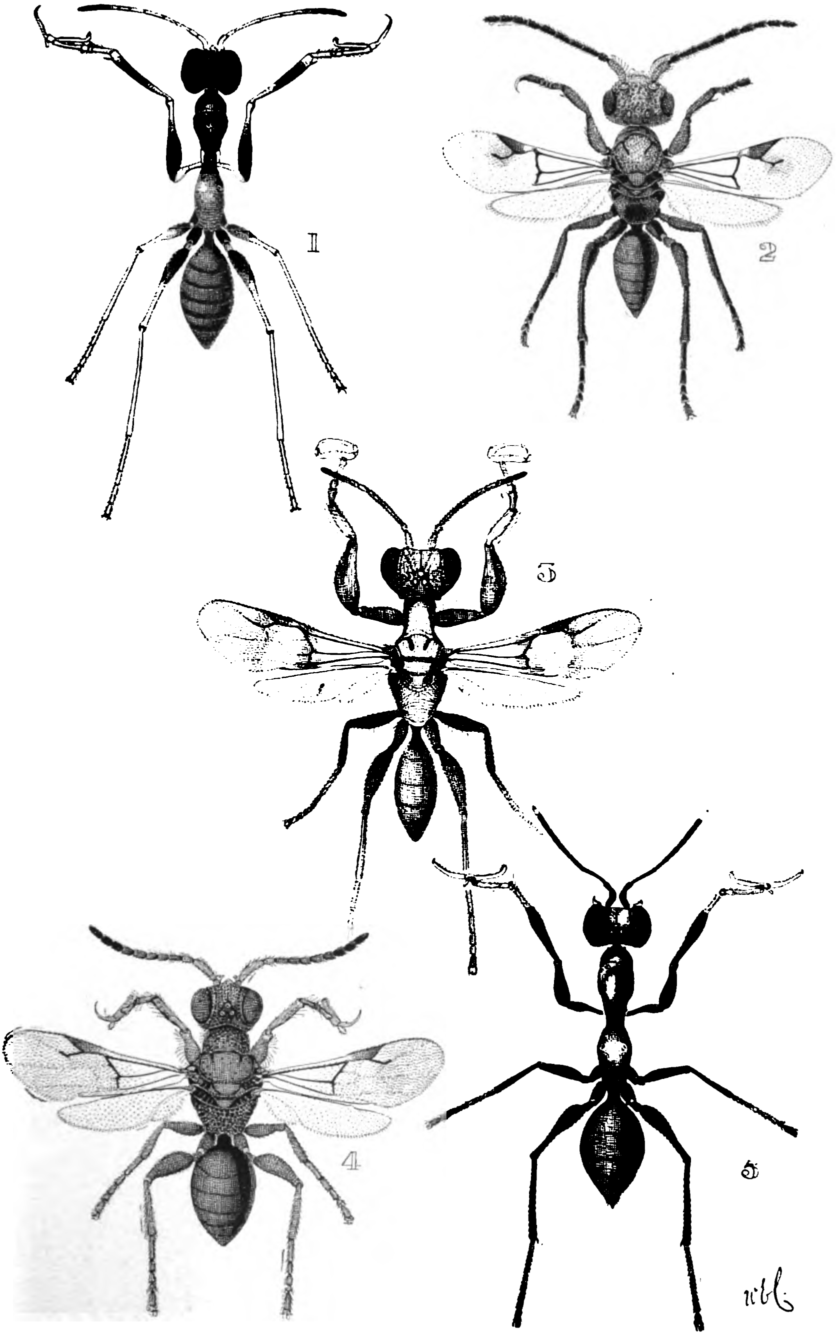

PLATE IV.

ENTOMOLOGICAL SERIES BULLETIN NO. 12

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

On Some New Species of Leaf-Hoppers

BY G. W. KIRKALDY AND F. MUIR

HONOLULU, HAWAII
JANUARY, 1913

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the
Hawaiian Sugar Planters' Association,
Honolulu, Hawaii.

DEAR SIRS:—I herewith submit for publication as Bulletin No. 12, of the Entomological Series, a collection of notes by the late Mr. G. W. Kirkaldy and by Mr. F. Muir, entitled: "On Some New Species of Leaf-Hoppers."

Yours very truly,

C. F. ECKART,
Director.

This Bulletin consists of descriptions of some of the new species of Fulgoroidea in the collection of the Hawaiian Sugar Planters' Experiment Station, collected by Mr. Koebele and myself during our investigations abroad.

The first part is from manuscript notes left by the late Mr. G. W. Kirkaldy. The delay in publishing these descriptions is to be regretted, as some of the names may now be synonyms, but the illness and sudden death of Mr. F. W. Terry, who had the disposing of the library and papers of his former friend and colleague, has been the cause of the delay, and now the doubly sad task falls to me. I publish Kirkaldy's notes as he left them, uncorrected, as my present knowledge of some of the families he deals with is not sufficient to allow me to correct his work.

The second part is by myself, with a few of Kirkaldy's descriptions incorporated. It deals only with the family Derbidae.

F. M.

PART I.

By the Late G. W. Kirkaldy.

FAMILY *CICADIDAE.*

(The following are not arranged phylogenetically.)

Cicada pontianaka Distant.

Hab. Borneo, Pontianak Muir. Previously recorded also from the Malay Peninsula, Sumatra, Java, and Sulu. The two males before me agree generally with Distant's figures and descriptions, except that either they differ a little as regards the pygophor, or else his figures are bad.

Platypleura canescens (Walker).

Hab. Larat (Muir). Previously also from Sumatra, Banda, Timor Laut, and Aru.

P. nobilis (Germar).

Hab. Borneo, Telok Ayer (Muir). Previously from India, Assam, Java, and Sumatra.

P. lyriccn sp, nov.

Male and female closely allied to *ciliaris* (Linneus). Pale greenish-ochraceous; vertex with a large median piceous suffusion which is continued to the margins by broad lines as follows: two lateral on each side (the second actually on the fastigia), and five basal, so that the vertex seems to be piceous with about six marginal pale areas; frons more or less piceous basally, some markings on legs, the tarsi, apex of labium, etc., blackish. Pronotum with a blackish line down the middle reaching to the anterior margin of the hind reflected part, and two or three short oblique lines on each side of this. Mesonotal markings much as in *ciliaris,* anterior half or so of the urotergites dark piceous, the last two or three segments mostly so. Urotergites more or less clouded with fuscous. Tegmina whitish tinged with fawn, with pale golden-yellow pubescence; veins pale yellow, green and red; clavus and base of corium dark, a fuscous oblique band from the exterior margin to the apex of the clavus, on basal third; the middle third and a little apical of that has a number of dark (thinly margined) rings in two or three rows (which in one doubtful female are almost absent), the apical margin is irregularly fuscous. Wings dark orange-brown, marked much as in *ciliaris,* but much more strongly and clearly cut, with blackish brown.

Structurally this species differs from *ciliaris* in the male by the opercula being remote inwardly, the inner margin, in fact, not extending quite so far inwardly as the hind coxae; they are transverse, and the spine of the hind coxae is long and acute. The male pygophor is bluntly carinate beneath down the middle, apically truncate, very slightly emarginate, broadly sulcate, this sulcation widening in the middle.

Length 9-12 mm.; width of pronotum 10½-11 mm.; expanse of tegmina 60-67mm.

Hab. Ambonia (Muir).

Baeturia conviva (Stal).

Hab. Amboina and Larat (Muir). Previously from Papua and almost all the Austromalayan Islands. Doubtfully distinct from *B. exhausta* (Guérin)

Scieroptera splendidula (Fabricius).

Hab. Java, Pekalongan, Borneo, Moewong (Muir). Previously recorded from throughout the Oriental region, except the Philippines. The examples before me are intermediate between *splendidula* and *crocea;* they differ from the latter, to which they are more immediately referable, by the immaculate black head, the pale bronzy-fuscous tegmina, with the cells medially paler.

Huechys vidua (A. White).

Hab. Borneo, Moewong (Muir). Previously from the Malay Peninsula.

H. sanguinolenta (Fabricius).

Hab. Macao (Muir). Distributed over almost the whole Oriental region as well as Sumbawa and Timor Laut.

Prasia elegans sp. nov.

Female bright yellowish-green; the apical margin of the head dorsally, narrowly, the base of the vertex, its porterolateral angles broadly, a large portwine glass-shaped mark on the mesonotum, all the mesonotal margins narrowly (excluding the basal elevation), and two submedian wedges, velvety-blackish. The head dorsally with sparse, short, black hairs. Abdomen above brownish-orange basally and laterally (irregularly) blackish. A silvery pubescent spot basolaterally and a percurrent stripe of silvery pubescence across the fifth urotergite. Beneath blackish with sparing pubescence of mixed silvery and pale golden pubescence. Fore and middle coxae dark crimson, margined narrowly with black, femora black with a broad red stripe inwardly; tibiae and tarsi crimson. Hind legs yellowish testaceous, femora and coxae more or less sanguineous. Tegmina hyaline, basal half of subcostal and radical veins on basal fifth yellow, shading to green up to about the middle, the rest black. Wings hyaline, subcostal and the base green, rest black.

Head dorsally slightly longer than wide between the eyes, vertex produced a little in front of the eyes, apical margin, where not interrupted by the frons, truncate; dorsal part of frons nearly or quite as long as the vertex medially, the latter deeply rotundately emarginate to receive it, anterolateral angles of the middle part of the vertex acute, prominent. Pronotum as long as, or slightly longer than, the head.

Length 15 mm.; width of base of pronotum 6 mm; expanse of wings 46 mm.

Habitat, West Borneo (Muir).

Cosmopsaltria alticola Distant.

Hab. Borneo, Pontianak (Muir).

Variety *Pontianaka* nov. This agrees generally with Distant's description, except that the apical veins have each an infuscate spot near the apex.

C. spinosa (Fabricius).

Hab. Borneo, Pontianak (Muir). The basal sides of the first, second, third, fourth, fifth, and seventh apical cells are infuscate, and the male opercula extend nearly to the apical margin of the fifth urosternite, not of the fourth, as figured by Distant, otherwise these examples accord.

C. duarum (Walker).

Hab. Borneo, Pontianak (Muir). Previously also from the Malay Peninsula.

Leptopsaltria pryeri Distant.

Hab. Borneo, Telok Ayer (Muir).

Pomponia imperatoria (Westwood).

Hab. Borneo, Telok Ayer (Muir). Previously also from Malay Peninsula, Java, and Sarawak.

FAMILY *CERCOPIDAE.*

Subfamily *Machaerotinae.*

I consider that the *Machaerotinae* are simply *Cercopidae* with simplified venation, both of tegmina and wings, and with more or less produced nota; they are a side branch of the *Cercopidae*, and *in no way* a link between them and the *Membracidae,* which are a development of the *Tetigoniidae* (or *"Jassidae"*) and lie right on the other side of the latter. The *Membracidae* are simply *Tetigoniids* with modified face and legs, and with a more or less ornamental nota. This development is merely analogical between the *Machaerotinae* and *Membracidae,* and *in no way* homological, as in the former it is mesonotal, in the latter pronotal!

Pectinariophyes Kirkaldy.

The hind tibiae are bispinose, but the basal one is minute.

Polychaetophyes Kirkaldy.

This genus is very close to *Machaeropsis* Melichar, and may prove identical. The head, however, is much shorter and broader, and very much more declivous, the face is broader and shorter, the scutellum is scarcely, or not at all, grooved mediolongitudinally, and the apical cells of the tegmen are four or more, though two or more of these are small.

Machaerota moluccana sp. nov.

Apparently allied to *M. ensifera* Burmeister, but the scutellum is tricarinate, its process much more arched, and the pronotum is not striped.. Purplish piceous; the pronotum browner along the posterolateral margin, and the scutellum with a short whitish longitudinal streak basally on each side; the process is brownish-yellow. The face is unicolorous, but has thin, lateral, silvery radiating lines. Fore and middle legs brownish-yellow; hind legs brownish-piceous. Sterna and base of abdomen beneath partly pale. Tegmina yellowish-hyaline, veins brownish-yellow, the costa and subcosta darker for the greatest part of their length. Wings hyaline, veins blackish-brown. Vertex scarcely, though very nearly, as long as in *ensifera,* rounded anteriorly, rather longer than wide between the eyes (or at least as long). Venation of clavus much as in *ensifera*. The rest of tegmen agrees fairly well with that of *ensifera* as figured by Schmidt, though not by Distant. The scutellum is more arched and the posterior margin is vertical and nearly as long as the distance between it and the pronotum; it is strongly compressed and tricarinate along the top, the lateral keels being evanescent anteriorly, the middle one evanescent posteriorly; the process is arched and rounded, the posterior being deflected. Head and pronotum slightly carinate longitudinally.

Length to apex of abdomen 6½ mm.; to apex of process in straight line 9½ mm.; to apex of closed tegmina 8¾ mm.

Habitat Amboina (Muir, Nov., 1907).

FAMILY *FULGORIDAE.*

The type of the genus *Fulgora* has been wrongly determined by all recent authors. The genus was erected by Linneus in 1767 (Syst. Nat. (Ed. 12) I 703), and the type was fixed by Sulzer in 1776 (Abgek.Gesch. Ins. 85), as *europaea* Linneus. This being the earliest genus, the superfamily and family take their names from it. For *Fulgora* auctt. (type *laternaria* Linneus), the name *Laternaria* Stal 1866 should be used. The subfamily formerly known as "*Fulgorinae*" should be known as *Lystrinae*.

Subfamily *Lystrinae.*

Cyrpoptus suavis Stal.

Habitat Mexico, Cuernavaca (Koebele). The males are as figured in the "Biologia," but the females have the orange-yellow of the tegmina and wings replaced by sanguineous; the head, pronotum and scutellum are pale reddish-brown and the tergites dark orange-brown, in the latter sex.

Birdantis sp.

A somewhat immature specimen from Amboina (Muir), may be *delibuta* Stal (from Ternate), but I can not obtain the description; it is not *decens* or *pallescens*. If this specimen is, as I suppose, a *Birdantis*, then Stal was right in supposing that it ought to be placed in his "54" division, as the "claval vein" runs into the commissure before the apex of the clavus.

Scamandra merope sp. nov.

Apparently near *S. hecuba*, but differently colored. The upper surface dark greenish-brown; metanotum and underside, with legs, mostly blackish-brown, the femora very obscurely spotted with brown. Tegmina bright red-brown on basal three-fifths, rest yellowish-brown; an irregular, non-continuous blackish fascia across the tegmina just basal of the division; there are also one or two obscure spots on the basal part. Veins mostly concolorous with the ground color; the costal vein, basal cell, etc., blackish. Wings scarlet; a basal spot bluish-black; apical third continuous with hind margin and anal area, yellowish-brown, paling gradually to anal area. The red discal color is bordered apically with blackish. Two large spots on the vertex; the scutellum; abdomen above especially basally; some specks on the gastropleurites; and the tegmina largely, as well as some specks on the wings, covered with a cretaceous exudation. The frons is longer than wide, and there is a rather obscure sublateral keel (on each side), and an obscure median one only extending about one-third of the length. Apical half of clypeus keeled.

Length 18 mm.; expanse 53 mm.

Hab., Telok Ayer and Pekalongan (Muir).

Eurinopsyche arborea sp. nov.

Differs from *obscurata* by the size of the eyes, which in the latter are small, but in *arborea* occupy almost the whole height of the head in profile. The head is rather shorter than the abdomen, and the labium extends to the apex of the latter.

Length 20½-21 mm.

Hab.: Queensland, Brisbane, and Bundaberg (Perkins); arboreal.

Subfamily *Fulgorinae* (=*Dictyophorinae* Oliv.)

Udugama splendens (Germar).

I refer to this species some examples from Macao (Muir; also in my collection from J. C. W. Kershaw). It has also been recorded from India, Ceylon, Burma, Philippines, and Java. The sexes are somewhat dissimilar in size and color. The examples before me may take the varietal name *tibialis*, the fore and middle tibiae being distinctly bi- or triangulate with brownish, a character not apparently mentioned in any descriptions of the typical form. Melichar adds *Dictyophora indiana* Walker as a synonym, a name which Distant ignores.

Electryone gen. nov.

Differs from *Putala* Melichar by the vertex being regularly narrowed towards the apex, while in *Putala* it is suddenly narrowed before the eyes; the hind margin of the pronotum is obtuse-angularly emarginate, while in the latter it is somewhat rounded; the scutellum is rather flattish, while in *Putala* it is convex. Type *macaonica.*

E. macaonica sp. nov.

In appearance very similar to *Putala maculata* Distant, which apparently belongs to this genus, but differs as follows:

Vertex much shorter, scarcely longer in front of the eyes than the rest of the vertex, and more rounded apically; the radial vein very distinctly forked a little nearer the apex than is the medial vein; otherwise the venation is very similar; tegmina apically more fuscate. Frons much shorter, basal of the eye scarcely longer than a half of the rest; there are three keels (within the lateral keels), one median and two submedian, the latter meeting basally subroundedly.† Coxae and apical third of front tibiae dark piceous.

Length 8 mm. to apex of abdomen, 10 mm. to apex of tegmina.

Hab.: Macao (Muir; also in my collection from Kershaw).

Miasa smaragdilinea (Walker).

Hab.: Borneo, Moewong (Muir). Previously recorded from Tenasserim and Malacca. The examples agree fairly well with Distant's redescription and figure (1906 Faun.Ind.Rh.,III. 248, f.108), except that the frons is unicolorously ochraceous, and the clypeal band, etc., are creamy white. Beneath, the abdomen is orange-brown, the apical margins of the segments narrowly greenish, the lateral margins dark fuscous; the pygophor more or less dark fuscous.

Acarna sp.

Hab.: Borneo, Moewong (Muir). Probably new, but unfortunately I have not seen some of the Stalian descriptions in this genus.

Fulgora Linneus (= *Dictyophora* Germar).

This genus is decidedly heterogeneous and badly in need of revision. *Nersia* Stal is not, as Distant says, synonymous with *Dictyophora* (i. e., *Fulgora*), *bovina* may be taken as its type.

F. herbida (Walker).

Hab.: Mexico; Cuernavaca (Koebele). The two specimens agree very fairly with Walker's description, but not so well with

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† Distant's figure must be faulty, as it shows only two keels within the lateral ones.

Distant's figure in the "Biologia," as the mesonotum is actually greenish; the stigma, moreover, is not represented in the figure and the venation does not quite correspond. For these two specimens, I found the subgenus *Cuernavaca,* separable from *Fulgora* (type *europaea*) as follows:

Vertex scarcely extended before the eyes, the lateral keels meeting roundedly in front; the middle keel visible only near the base. Pronotum very obscurely keeled, anterolateral margins somewhat rounded. The lateral keels of the scutellum are arched outwardly. The frons scarcely extends backwards from the eyes and is somewhat rounded basally; the lateral margins diverge towards the apex, but narrow again just before it; the sublateral keels form an elongate oval, not touching the other margins at any point, the middle keel being percurrent within them. Clypeus feebly carinate. Tegmina much less reticulate; stigma four-celled. As in *Fulgora,* the hind coxae are acutely spined; the hind femora are four-spined; the labium reaches to the hind trochanters.

In the following species the hind margin of the pronotum is minutely, but very distinctly, notched in the middle, whereas in *F. europa* it is notched almost imperceptibly.

Fulgora nereides sp. nov.

Belongs to, or near, the typical subgenus. Head green, the vertex between the lateral keels, the dorsal part of the genae and th middle keel (suffusedly) of the frons, red. Clypeus yellow, the basal half of the keel red. Underside yellowish. Pronotum and scutellum reddish (or sometimes sordid yellowish-green), the keels (suffusedly on pronotum) green. The main veins of the hyaline tegmina are more or less orange-yellow, those on the apical third yellowish-fuscous, the rest greenish. Legs yellowish-red, greenish on coxae and at base of femora; extreme apex of femora, apex of tibiae and apical segment of tarsi, blackish. Vertex not quite so long as the scutellum, ascending a little in front of the eyes at about 45 degrees, the lateral keels arched outwards at first to a little beyond the eyes. thence converging acuminately, so that part of the obliquely-lying genae is clearly visible dorsally; at the extreme apex, a part of the frons is also visible dorsally. The frons is very elongate, the lateral margins strongly narrowed towards the base, and slightly widened at the apical margin; medial and lateral keels of frons and clypeus strong, but the submedian keels of the former are obsolete on the apical half; the lateral keels are not visible, ventrally, at the base itself. The hind femora have five spines; hind tibiae about two and a half times longer than the femora. Antennae small, but larger than in *europaea,* second segment subglobose, apically oblique, the flagellum not arising from the apex.

Length 13 mm. to apex of abdomen; 17 mm. to apex of tegmina.

Hab.: Amboina (Muir); Borneo, Telok Ayer (Muir).

F. glaucides sp. nov.

Superficially not unlike *F. nereides,* but the head is much less ascendant, and there are eight femoral spines.

Head and prothorax green, rest of the thorax and abdomen more or less yellowish, mostly rather pale. A percurrent stripe from base of pronotum to apex of vertex, another from base of frons to apical margin, another from anterior angle of genae to base of propleura (interrupted by the eye), a sublateral oblique (more obscure) stripe on pronotum, sanguineous. Scutellum more or less suffused with green. Middle keel of clypeus pale sanguineous. Costal vein fuscate, tinged with sanguineous at base; other veins more or less greenish on basal third, shading into tawny on middle third, and into fuscous on apical third, but all a little intermixed. Coxae, femora, and hind tibiae, greenish; fore femora and hind tibiae more or less tinged with brownish on apical half or so (varyingly). Head very little ascendant, about as long as the scutellum, 3½-4 times as long as width between the eyes; lateral margins subparallel to about a little in front of the anterior margin of the eyes, thence acutely converging; the rounded outline of the obliquely lying genae is visible dorsally; also the actual apex is rounded, owing to part of the frons being visible. The frons is very similar to that of *nereides,* except that it is a little less elongate, and more rounded anteriorly, and not so elongate after the disappearance of the genal keels. Apical venation much as in *nereides.* Hind tibiae about 3 times as long as the femora, with eight spines, the five basal small but distinct, the three apical large.

Length 12 mm. to apex of abdomen, 17 mm. to apex of tegmina.

Hab.: Borneo, Telok Ayer (Muir).

F. borneides sp. nov.

Scarcely separable from *F. europaea* by color and pattern. Structurally it may be separated as follows:

Vertex slightly longer, and the lateral margins almost straight, less acute apically; the genal margins as seen dorsally are more arched outwardly. The claval veins unite in the same line as the forking of the brachial, instead of distinctly basal of it; the cells formed by the forking of the main veins are distinctly longer, and the tegmina themselves are much longer; also the apical third is less reticulated. Frons rather longer and narrower, more rounded basally, apical margin very slightly narrower than base of clypeus. Antennae a little more globose.

Length 10 mm. to apex of abdomen, 16 mm. to apex of tegmina.

Hab.: Borneo, Moewong (Muir).

Amboina gen. nov.

Superficially like a long-headed Hasta, but distinguished, from all the old-world *Fulgorini* near the typical genus, by the lack of a stigma, and the *comparatively* long antennae.

The general characters are those of *Hasta,* but it differs as follows: The head anteriorly widens but a little at the apex; it is distinctly narrowed and constricted between the eyes. The eyes are comparatively large and prominent and well rounded exteriorly. The antennae, though short, are yet not of the microscopical size usual in this division, but are distinctly visible from above. The pronotum is much longer medially, being about half the length of the scutellum. The frons is five-carinate, the submedian keels being obsolete between the base of the clypeus and the constriction. The clypeus is very obscurely keeled. The labium reaches the hind trochanters, the third segment being much longer than the fourth. Tegmina more closely reticulated on the apical third, more as in typical *Fulgora;* stigma lacking, but there are about eight suboblique veins on the apical third of the exterior area. The legs are all long and slender, the hind tibiae being more than three times as long as the femora; the latter have five spines, but the basal one is very obscure. Fore femora spineless. Abdomen elongate. Type *moluccana.*

A. moluccana sp. nov.

Male grass green, shading off in parts into pale yellowish-green; metasternum whitish; lateral margins of vertex very narrowly sanguineous. Head nearly twice as long as the pronotum and scutellum.

Length 19-19½ mm.

Hab.: Amboina (Muir).

Orodictya gen. nov.

Differs from *Thanatodictya* as follows: the elongate vertex is not sulcate (the lateral keels being obsolescent) except between the eyes. The disks transversely rugulose, as also beneath and laterally. (The middle keel is apparently only between the eyes as in *Thanatodictya.*) The vertical process is very slightly enlarged at the tip where it is rounded. The five frontal keels are all percurrent. Eyes elongate, not rounded laterally. Hind tibiae with seven to nine spines. Lateral keels of pronotum obsolescent. Apical margin or tegmina broadly multireticulate.

Superficially rather like *Acarna* Stal, but the front is not angulately ampliated; the pronotum is rather deeply emarginate, the fore tibiae are not at all dilated and the hind tibiae are at least quadrispinose apical of the middle.

O. monticola sp. nov.

Pale olivaceous-brown. Keels most greenish (or pale yellowish). Beneath pale yellowish, tinted in parts with greenish or brownish. Fourth segment of labium blackish.. Legs very pale greenish, apical one-third of the whole tibiae darker green, basal two-thirds yellowish, apex of hind tibiae and the hind pairs, reddish. Tegmina hyaline, veins dark crimson red (except the green costal). On the apical one-third of tegmen, the crossveins are infuscate, and the apical margin from near the claval apex to the base of the stigma, is broadly (irregularly) reddish ferruginous. The stigma has five or six cells, but is rather confused apically. Wing veins blackish, the apical margin infuscate. Length from tip of head to apex of closed tegmina 22 mill., length of head 5½ mill.

Hab.: Borneo, Moewong (Muir).

RICANIINAE.

Armacia hyalinata (Donovan).

Hab.: Amboina (Muir). Previously also from New South Wales, Papua, Solomon Islands and Ternate.

Ricania speculum (Walker).

Hab.: Borneo, Pontianak, and Telok Ayer (Muir). Previously also from India, Assam, Ceylon, Burma, Tenasserim, Oriental China, Philippine Islands, and Java. Melichar adds (but perhaps through mistaken synonymy) Waigiu, Flores, Singhapur, Siam and Sumatra.

Ricania moluccana sp. nov.

Sooty; labium and legs yellowish-brown, femora, apices of tibiae, etc., dark fuscous. Abdomen piceous. Tegmina dark smoky, partly with a purplish submetallic glint; a small round purplish metallic spot near the middle of the corium, a series of yellow specks at the end of each costal veinlet as far as the stigma, also a series of smaller byaline specks along the apical margin. Vertex very transverse. Keels of pronotum, scutellum and frons very distinct. Four veins arise from the basal cell, the radial and subradial running parallel. Shape of tegmina much as in *decorata,* but the apical margin rather longer and the hind margin rather shorter in proportion.

Length of body 4 mill.; expanse of tegmina 14 mill.

Hab.: Amboina (Muir).

This appears to belong to *Ricanoptera,* which I can regard only as a subgenus of *Ricania.*

Ricania indicata Melichar.

Hab. Amboina (Muir). Also previously recorded from Ke and Timor Deli.

Ricania stigmatica var. *borneensis* nov.

Hab.: Borneo, Telok Ayer (Muir). It has no white stigmal spot. *R. stigmatica* was recorded from Java.

Ricania laratica sp. nov.

Apparently near *eximia.* Head pitchy brown, vertex and genae partly browner. Pronotum, scutellum, pro- and mesosternum sooty. Tegmina dark smoky, veins blackish, a pale ocellate stigmal spot, and a white wedge-shaped spot on the costal margin near the apex, and another similar one near the apex on the apical margin. A small obscure hyaline speck about the middle. The basal third of the costal margin speckled with yellowish. Abdomen more or less brownish-pitchy. Legs brownish-yellow, more or less dark fuscous on femora and apex of tibiae. The tegmina are sprinkled more or less with greenish-yellow.

Length of body 6 mill.; expanse about 18 mill.

Hab.: Larat (Muir).

The three specimens before me are practically identical. The keels are well marked, the submedian ones on the scutellum being rounded from the apical margin instead of being sinuate, as in *indicata.*

Pochazia fuscata (Fabr.).

Hab.: West Borneo, Telok Ayer (Muir). Previously from India, Burma, Tenasserim, Malay Peninsula, Sumatra, and Java.

Sassula dyakana sp. nov.

This species differs from *sororcula* by the radial vein not being forked; from *osmyloides* by the different venation.

The spotting of the vertex and nota is not unlike that of *sororcula;* the frons has three short, dark, lanceolate lines at the base between the four keels; there is also a dark spot on each side (inside the lateral keels), near the antennae, and another at the apex of each submedian keel just apical of the basal margin; there is no other specking or spotting on the frons, which is distinctly wider and shorter apically of the antennae than in *osmyloides,* and the lateral margins are more sinuate. The costal area is distinctly wider than the subcostal area; there are two spots on the subcostal area near the base. The venation of the corium is very much like that of *sororcula.*

Length 10 mill.; expanse of tegmina 33 mill.

Hab.: Borneo, Telok Ayer (Muir).

Gaetulia nigrovenosa Melichar.

Hab.: Java (Muir). Previously recorded from India, Assam and Tenasserim.

Nurunderia chrysopoides= *Gaetulia chrysopoides* Kirkaldy.

Distant has (1909 A. M. N. H. (8) IV.337) erected the genus *Nurunderia* for this species.

Mindura obscura (Fabr.).=*sundana* Kirkaldy.

Hab.: Amboina (Muir). Previously found in Java and South India.

Nogodina pallidipennis (Guérin).

Hab.: Amboina (Muir). Previously also from New South Wales and Vanikoro.

FLATINAE.

Amphiscepa bivittata (Say).

Hab.: Mexico, Morelos (Koebele). Previously recorded also from Canada and the United States.

Amphiscepa immaculata Kirkaldy.

Hab.: Mexico, Orizaba. Previously from South Arizona.

Neomelicharia guttulata (Stal).

Hab.: Amboina (Muir). Previously known from Buru.

The ground color of the tegmina may be milky or yellowish-green. The anteroapical angle of the tegmina is often black, as also a spot at the apical angle of the clavus and another near base of the same interiorly. The pattern is exceedingly variable. The forms which have milky-white tegmina (this does not appear to be a post-mortem change) may be called var. *lactealis.*

Neomelicharia ocellifera (Walker).

Hab.: Ambonia (Muir). Previously known also from Ceram and Java.

Colgar chlorospilus (Walker).

Hab.: Amboina (Muir), with vars. *decolor,* etc. Previously reported from Papua and Birara.

Colgar laraticus sp. nov.

Green, paler beneath, scutellum yellower. A rather broad stripe from apex of vertex to apex of metanotum, all the margins of the tegmina (except the extreme base of the costal), fore and middle tibiae, the frontal keels very narrowly basally, etc., bright crimson; tegmina otherwise immaculate. Vertex very slightly longer than pronotum, rather more sharply keeled than in the other species of this genus (as also on pronotum and scutellum), thus approaching *Phyllyphanta.* Frons with three keels, much as in *chlorospilus.* Anteroapical angle of tegmina acute, posteroapical angle rectangular, slightly rounded.

Length of body 7 mill.; expanse of tegmina about 18 mill.

Hab.: Larat (Muir).

In immature individuals, the red is replaced by pale orange. It is possible that this is only a var. of *surrecta,* which I do not know.

Colgar granulatus sp. nov.

Very similar to *laraticus,* but the tegmina are distinctly broader, especially basally; the red stripe is absent, only the apex of the head being a little reddish. The red margination of the tegmina is very narrow and obscure. The ground color of the tegmina is yellowish-green, the veins being suffusedly greener, and especially on the apical half being excessively minutely granulated with purplish-brown.

Length of body 8 mill.; expanse of tegmina 20-21 mill.

Hab.: Larat (Muir).

Colgar surrectus (Melichar).

Hab.: Larat (Muir).

Phyllyphanta producta (Spinola).

Hab.: Borneo, Telok Ayer (Muir). Previously known from Sumatra, Banguey, Java, Celebes, and Cochin China.

Salurnis kershawi sp. nov.

Head, pronotum and scutellum pale orange-brown, the disk of the pronotum and of the scutellum pale greenish-yellow, the former with a red-brown stripe down each side of the middle, the latter with an outwardly curved submedian pale brown stripe, meeting apically and basally. A broad fuscous stripe down the middle of the vertex, a fuscous spot at middle of the apical margin of pronotum and of scutellum. Sterna and abdomen pale, the latter more or less yellowish above. Tegmina pale yellowish-green, the veins suffusedly pale fuscous, the commissural margin suffusedly so. Wings milky white. Legs testaceous, tarsi, fore tibiae, etc., pale yellowish-brown. Vertex about half as long as the pronotum, scarcely half as long as the width of the head between the eyes. Anterior margin of pronotum rounded, subtruncate in the middle. Tegmina costally strongly arched, apical angle rounded, posteroapical angle acute, prominent. No sensory granules on corium.

Length of body 7 mill.; expanse of tegmina 19 mill.

Hab.: Macao (Muir; also in my collection from J. C. W. Kershaw).

There are two sublateral, outwardly arched, keels on scutellum, and between these, on each side of the middle, a more obscure one. This species is very similar to *marginellus*, but is yellower, and the vertex distinctly shorter, and the pronotal keels more distant. It seems to lead the way to *Siphanta*.

Salurnis marginellus (Guerin).

Hab.: Borneo, Telok Ayer (Muir). Previously recorded also from India, Tenasserim, Malacca, Cochin China, Shanghai, Kiang-Sin, and Nicobar Islands.

Siphanta javana sp. nov.

This has the characters of *acuta* (Walker), but is distinctly smaller with the anteroapical angle of the tegmina less prominent, and is distinguishable at once by the numerous tubercles on the tegmen. It is smaller than *acutipennis* Kirkaldy and has a distinctly shorter vertex. It is separable from *patruelis*, the other Javan species, by the rounded vertex and narrower frons.

Length 5 mill.; expanse of tegmina about 18 mill.

Hab.: Java, Pekalongan (Muir).

Mimophantia maritima Matsumura.

Hab.: Amboina (Muir). I cannot see any difference of importance between these Moluccan specimens and the descriptions of those from Japan.

Phyllodryas gen. nov.

Vertex very short, its apical margin touching the apical margin of the pronotum in the middle. Frons about as long as wide, lateral margins rounded, acute, reflexed; with a median keel which is not quite percurrent apically. Pronotum not, or very obscurely, carinate. Scutellum with three very obscure keels. Tegmina scarcely twice as long as their middle width, outer fork of the brachial vein joined to the inner fork of the median by two or three short, transverse veins; a regular, transverse, subapical line close to the apical margin, apical angles well rounded. Hind tibiae with one spine. Type *calamantina.*

This genus has some resemblance to *Paratella,* which, however, has no subapical line and has different venation; it differs from *Hilavrita* by the unispinose hind tibiae; from *Petrusa* by the tegmina having one subapical line; and from *Tejasa* by the presence of a number of transverse lines basal of the subapical line. From all these, moreover, it differs by the presence of a few veins in the clavus, but does not come near any of the other genera thus characterized. It has considerable resemblance to *Odyxa truncata?* Distant (not Melichar), but has only one subapical line; Distant figures none, in the supposed Linnean species, but says that it might well be placed in *Cryptoflata,* i. e., *Flata* Fabr., but the latter has more than one subapical line, according to its founder, though not according to Distant, and has two femoral spines.

Melichar's species has evidently, from the description, nothing to do with the supposed Linnean type, the shape of the tegmina alone showing this, and may be renamed *melichari.*

Phyllodryas calamina sp. nov.

Male and female pale greenish or testaceous; tegmina creamy, apical margin (apical of the submarginal line) and the commissural margin in part, pale yellowish fuscous.

Length of body 5 mill.; expanse of tegmina 17 mill.

Hab.: Borneo, Telok Ayer (Muir).

Nephesa rosea (Spinola).

Hab.: Borneo, Telok Ayer (Muir).

Nephesa aurora sp. nov.

Pale brownish-testaceous; apical margin of the second segment of the antennae, third segment of the hind tarsi, etc., fuscous. Tegmina pale rosy, the apical margin and the apical half of the hind margin, pale orange-brown; wings milky. Vertex very short and transverse, the rounded frons partly visible dorsally. Middle keel of pronotum very obscure. Tegmina elongate, apical margin very oblique, apical angles rather prominent, rounded.

Length of the body 12 mill.; expanse of the tegmina 53 mill.; lengths of the fore, apical and hind margins, respectively, of the tegmina, about 25, 13 and 18 mill.

Hab.: Amboina (Muir).

Nephesa coromandelica (Spinola).

Hab.: Borneo, Telok Ayer (Muir). Previously known from Java. The South Indian record is perhaps incorrect.

Hansenia kirbyi Melichar.

Hab.: Borneo, Pontianak (Muir). Previously known from Ceylon. Distant (1906 Faun.Ind.III.411) synonymyzes this with *glauca* (Kirby), apparently incorrectly.

Ormenis dolobrata Fowler.

Hab.: Mexico, Morelos (Koebele).

Ormenis plebeia sp. nov.

This species has the general appearance of *dolobrata,* but differs as follows:

The vertex is distinctly narrower and the eyes smaller; the frons is much less narrowed towards the apex and is scarcely a fourth narrower at the apex than at the base (instead of about one-half); the frontal keels are very obscure, and instead of being truncate, the apical margin of the frons is slightly emarginate. In *dolobrata* the hind margin of the pronotum is obtuse-angulately emarginate; in *plebeia* it is roundly so, and the hind angle of the scutellum is much less elongate and prominent. The pronotum and scutellum are pitchy-brown, the head paler, frontal keels yellowish-brown. In the tegmina the pale spot is much less clear and the apical third is rather more closely reticulate. The clavus is distinctly more strongly granulate. Legs browner.

Lengths of body 6½ mill.; to apex of tegmina 9 mill.

Hab.: Mexico, Cuernavaca (Koebele).

ISSINAE.

Hemisphaerius Schaum.

This genus is in a very unsatisfactory state, despite the revisions of Butler and Melichar. These revisions have been made practically entirely on color and pattern, which are, judging from the material before me, somewhat variable, certainly rendering invalid Melichar's preliminary divisions of dark and pale forms. At the same time I have made a new species on color and pattern, as I have not the necessary material in other species to form an opinion as to what structures are valuable for specific purposes.

Hemisphaerius moluccanus sp. nov.

Male and female not very shining. Vertex, basal margin of frons, a transverse stripe on the frons at the apical margin, antennae, pronotum, scutellum, legs, etc., ochraceous. Clypeus and rest of frons, genae, and most of the abdomen beneath, dark piceous. Tegmina ochraceous, very closely lined irregularly longitudinally (and shortly furcately) and specked with pale greenish. Vertex more than twice as wide as its length, not longer (scarcely as long) than an eye, with two pits.

Length to apex of tegmina 4 mill.

Hab.: Amboina (Muir).

Hemisphaerius javensis Melichar.

Hab.: Larat (Muir). Previously recorded from Java. One example is suffused with rosy. This species also varies as follows. The tegmina from uniform pale green to piceous, there being intermediate forms. The frons from immaculate green to blackish with a pale green transverse stripe at the apical margin.

The nymph is like the adult, except that the hind tibiae are rather dilated; the clypeus is pale green.

The nymph has a double row of oblique granules on the pronotum, the apical the longer. The large development of the tegmina makes the hopper very wide. The hind tibiae are flattened and widened and have one median spine.

The coloring is pale greenish, yellower on head and pronotum, the urotergites very closely specked with brown. Legs brownish-yellow, femora more or less infuscate. Sternopleurites mostly fuscate.

Hemisphaerius tristis Stal var. *lineatalis* nov.

Hab.: Amboina (Muir). The type was from Batchian.

This agrees with the description of *tristis*, as far as it goes.

except that the pronotum is almost entirely ochraceous (this varies somewhat), and there is a generally percurrent ochraceous line down the scutellum.

Gelastissus albolineatus Kirkaldy.

Hab.: Amboina. Previously from Queensland.

G. histrionicus Kirkaldy.

Hab.: Amboina. Previously from Queensland.

G. suffusus Kirkaldy is merely a variety of this; one of the Amboina specimens has the apical parts of the tegmina piceous.

Lollius furcifer Stal.

Hab.: Amboina (Muir). Previously from Timor, Batchian, Ke, Solomons, Fiji, and the Nicobars.

Thaebena stali, Melichar.

The type of this genus, which Melichar could not trace, was fixed by Stal as *retractus* (Walker). The present species differs from that, by the frons being much longer than broad, while the head pronotum, frons, etc., are the same color, viz., reddish-ochreous. From *T. stali* Melichar (typical) it differs only by the lateral margin of the vertex diverging emarginately, roundly, towards the base which is wider than the apical margin. It is slightly wider at base than long.

Hab.: Borneo, Moewong (Muir). Previously from Singapore.

Capelopterum bimaculatum Melichar.

Hab.: Amboina (Muir). Papua.

Apheloncma vespertina sp. nov.

Allied to *A. rugosa* (Ball), but the clypeus has no pale median line, and the vertex proper is roundly triangular.

Pale yellowish-testaceous, lateral margins of the vertex proper, of the pronotum, and of the flat part of the scutellum, pale piceous, the sloping sides of the scutellum dark piceous. Frons slightly clouded with fuscous on its flat disk, outside the circular keel it is almost entirely dark piceous, as also are the genae between the eyes and antennae, and clypeus (except at extreme base). Tegmina pale, laterally indefinitely pale fuscous, venation white. Urotergites medially pale olivaceous, a very narrow white undulating line separating this from the dark piceous hue which suffuses most of the lateral part, especially towards the middle. The median part might be flecked with pale purplish-red. Beneath dark piceous with a few irregular yellow spots; coxae mostly dark piceous; tibiae with dark piceous bands, etc.; antennae black. The pustules are pale and well marked on the frons outside the circular keel, and on the pronotum, scutellum, and urotergites laterally. The vertex is as long as the pronotum, and is roundly triangular, the parts of the frons outside the circular keel being thus visible from above. Tegmina are formed much like those of *rugosa*. The outer keels of the frons form a circle, which does not touch the clypeus, but touches the vertex.

Length 3.5 mill.

Hab.: Mexico, Chapultepec (Koebele).

Bruchomorpha dorsata Fitch.

Hab.: Mexico, Morelos, Cuernavaca (Koebele). Previously recorded from all over the United States.

The nymphs have very much the same form and coloring, except that the face is declivous.

Bruchomorpha mexicana sp. nov.

Pale yellowish-cinereous; vertex with four not perfectly defined blackish spots; frons pustulate, irregularly, blackish outside the oval keel, and of the same suffusion laterally and basally inside it; Genae mostly blackish; hind margin pale; pronotum very thickly pustulate and slightly clouded. Disk of scutellum slightly fuscous towards the hind angle; oblique sides thickly pustulate and more or less blackish-brown. Tegmina pale brownish-olivaceous, veinings pale. Urotergites thickly blotched and spotted with blackish-brown. Sterna pale brownish-yellow, most of the ambulacra of the middle legs black. Urosternites pale brownish-yellow, laterally blackish, this almost meeting basally. Legs pale brownish-yellow, irregularly marked with dark fuscous. Labium the same ground color, extreme apex dark.

The frontal keels are very strongly marked, the curved keels forming an oval, truncate basally, and roundly acute apically, the whole not so elongate apically as in *dorsata*. The frons is almost horizontal to the vertex, and the clypeus is apically horizontal to the frons, which is about one-half longer than its basal width. The tegmina are formed much as in *pallidipes*.

Length of female 3 mill., breadth 1.75 mill.

Hab.: Mexico, Cuernavaca (Koebele). Very different to any other *Bruchomorpha*.

Hysteropterum montezuma sp. nov.

Differs from *H. montanum* by the much shorter vertex, the angulate (or at least medially deflected) clypeus, the color, etc.

Testaceous, irregularly and obscurely, clouded more darkly. On the frons there are two transverse, obscurely indicated, pale bands, the rest minutely and thickly speckled. Tegmina greyish-testaceous, a broad blackish wedge from hind angle of scutellum to near the costal margin, as the base, the third angle about the middle of the tegmen a little inward; the two third angles (on each tegmen) are joined by an obscurely indicated dark. sinuate, transverse bands. The rest of the tegmen is closely specked more darkly. Abdomen and legs yellowish-testaceous, irregularly marked with black. Although the vertex is short, yet the frons is distinctly longer than wide, and there is a median percurrent keel which thickens in the clypeus. Pronotum nearly twice as long as the head. Scutellum rather obscurely tricarinate.

Length 4.25 mill.; breadth 2.8 mill.

Hab.: Mexico, Cuernavaca and Yantepec (Koebele).

PART II.

By F. MUIR.

DERBIDAE.

INTRODUCTION.

HABITS.

The species described in this Bulletin (except a few specially indicated) were collected during the time I was in Fiji and the Malay Archipelago, investigating insects injurious to sugar-cane.

Many species of this family are to be found in great numbers on sugar-cane, but only in the adult stage; the young and eggs I have never found on this host-plant. I am not acquainted with any record of the life-history of any species of this family, and I have never come across the eggs, but I have taken the nymphs of several species, all having similar facies and habitat. All these nymphs were living in rotten tree trunks, were dark in color, flattened horizontally, with wide faces, even in such forms as *Zoraida;* both in appearance and habitat they are similar to many species of *Oliarus,* but the females do not possess the large wax-plate at the end of the abdomen. Although the adults of some species collect in such numbers in cane fields, where they are very conspicuous on account of the habit they have of often sitting near together, in Indian-file, with their long wings over their backs, yet they never do any considerable damage; this must be attributed to the habit of the young of not feeding on sugar cane, for if they did their number, which is much greater than that of the adults, would cause considerable damage.

Another strange feature of these swarms of Derbidae is that they generally consist of only one sex and at such times it is very difficult to find the opposite sex.

That this interesting family of leaf-hoppers has been greatly neglected is shown by the fact that we know so little about their life histories and that I, although only collecting them incidentally, have been able to add 16 genera and 96 species to it. My collection is by no means representative as, confined to the cultivated areas by my special work, I collected but little in the natural forest where these forms are most numerous and diversified.

None of this family exists in the Hawaiian Islands, and even if one or more species should ever become established here, the fact of the young living in rotten timber would confine them to very limited areas.

CLASSIFICATION.

Among the characters which Stal ascribes to this family, the short, or very short, apical segment of labium is the most distinctive. *Nisia, Suva* and *Phaconeura* all possess a long apical labial segment; many of the species of these genera also possess a median facial ocellus and a large wax plate at the end of the female abdomen, characters which belong to the *Cixiinae;* the neuration of their tegmina is also very different from any Derbid. For these reasons I exclude them from the family *Derbidae,* but, inconsistently, have included them in this Bulletin because several of our greatest authorities on Homoptera have considered them as Derbids. There is no doubt that *Kermesia* is closely allied to these three genera and will also have to be removed from the *Derbidae,* although, according to Distant, it has a minute apical joint to the labium.

I have used the neuration of the tegmina for dividing the family into groups, and again for redividing the groups; it thus becomes necessary to use a more definite nomenclature than is usual with many workers in Homoptera. The terminology of Comstock and Needham has been employed as it is the one that is most generally known. To make sure of the different systems of nerves I have followed the development of the tracheal system in the tegmina of the nymph of several groups of Homoptera. The contention that without studying the development it is sometimes difficult, or impossible, to decide to which group the vein belongs, is no argument against the use of this system, as the same disadvantage is attached to any system. When we do know the development of a greater number of forms, I believe we shall be able to divide the Fulgoroidea into better defined and more numerous families. I have not used the neuration of the wings, as in so many forms they are so covered with waxy secretions that only by taking them off and cleaning them can the neuration be seen with any certainty, an operation that many workers would not perform with many of the small, delicate species, which are at present so rare in collections. Next to the tegmina the head and thorax present the best characters. In many forms there is a well-developed process below the antenna, *the subantennal process,* either in the form of a deep keel or plate, or a more or less spatulate organ. The best character on the pronotum is the absence or presence of the "shoulder keel"; this is a large carina, or flange, running from the anterior margin behind the eyes to the hind margin, with which it often amalgamates, forming, together with the lateral edges, which are sometimes curled forward, a "post-antennal chamber." The shortness of the pronotum is oftimes more apparent than real, on account of the median portion standing nearly perpendicular, being bent in the middle and fitted into the emargination of the vertex. The absence or presence of carinae on pronotum or scutellum is a very uncertain character, as many small light-colored species appear to have carinae on account of the three dark longitudinal marks, indicating the attachment of the thoracic muscles.

For specific distinction it is necessary to compare the genital armature in certain groups. The present study shows that very few species have a wide distribution among the Malay Islands, but certain of the species are difficult to separate except by the genitalia.

The family can be divided into four groups:

1. Tegmina exceptionally long and narrow, wings less than half the length of tegmina, sometimes very minute. . Group III
   Tegmina not long and narrow, wings more than half the length of tegmina. 2
2. Cubital veins not reaching to hind margin of tegmen, but ending in the extended claval vein; third claval cell open, extending along hind margin to last apical median cell. . . . . Group II
   Cubital veins ending in hind margin of tegmen, third claval cell closed, not extending to last apical median cell. 3
3. Cubitus simple or furcate, not running into first median sector . . . . Group I
   Cubitus with three or more branches (or the cubitus connected with the first median sector, forming an angular or diamond-shape cell) . . . . Group IV

The first, or *Cenchrea,* group is a natural one, and the forms included in it are closely allied; in many of the genera the systems of neuration are all separated from the base of the tegmina, such forms being the most generalized of the *Derbidae*. *Phaciocephalus miltodias* and *P. pullatus* are of interest as showing the commencement of the modification which distinguishes group two, namely, the opening of the third claval cell and the failure of the cubital veins to directly reach the posterior margin. (Pl. I f. 22, Pl. III f. 16.)

The second, or *Otiocerus,* group is also a homogeneous one and follows naturally after group one; it contains some of the most fantistically shaped insects of the family, such as *Swezeyia* with its bizarre shaped head, and *Megatropis,* with its wonderful, separate head-keels.

The third group is distinctly divided into two subgroups, the relationship between them being very indistinct and uncertain. The *Sikiana* subgroup consists of delicate little creatures, with wings apparently wholly devoted to sound production; the *Zoraida* subgroup also has very small wings with large anal areas, devoted to sound production, but never so greatly reduced as in the *Sikiana* section. It is among the *Zoraida* section that the most conspicuous forms of the family are to be found, and from whence the forms generally chosen to illustrate the family are taken. Among the genera of this section *Zeugma* stands apart as possessing both shoulder keels and subantennal processes and demonstrates the uselessness of the structure of head and thorax for primary divisions. *Diostrombus* and *Comma* are the two forms which approach nearest to the *Sikiana* section.

The last group is not a natural one; it consists of *Derbe* and *Mysidia,* which approach the *Zoraida* section of group three, the *Rhotana* section, which is somewhat aberrant, and the Nisian genera, which are not true Derbids. There is a touch of irony in the fact that *Derbe,* the type genus of the family, is not truly characteristic of any of the main groups. By discarding *Nisia* and its allies, and placing *Derbe* and *Mysidia* in the *Zoraida* group, the small *Rhotana* group could remain unattached.

Unfortunately there are certain genera of which the descriptions are not complete enough to enable me to include them in my tables. Working in a place away from large collections and libraries, one is dependent upon one's friends more fortunately situated. My thanks are due to the United States National Museum for sending me specimens for examination, and to Mr. W. L. Distant of the British Museum, for specimens, answers to many questions and much valuable information.

Roban and Pekalongan are in Java, Telok Ayer, Pontianak and Mowong in Borneo, and Laloki in British New Guinea.

When working with small and delicate insects like this family I use a Greenough binocular, as a single hand-lens is not suitable to recognize carinae, etc.

The measurements are from front of head to end of pygophor, not including the genital styles, and from base to apex of one tegmen.

GROUP I.

1. Subcosta and radia separate from near base of tegmen (subcostal cell long) 2
   Subcosta and radia contiguous to middle or beyond middle of tegmen (subcostal cell short)...................... 8
2. Subantennal process absent or very small............. 3
   Subantennal process well developed.................. 7
3. Shoulder keels absent, or only slightly developed....... 4
   Shoulder keels well developed 5
4. In profile face and vertex angular; lateral keels of face not contiguous ....*Goneokara*
   In profile face and vertex rounded; lateral keels of face contiguous to near apex ....*Cyclokara*
5. Vertex wide, length subequal to width of base......... 6
   Vertex narrow, much longer than wide....*Basileocephalus*
6. Face with central, longitudinal keel.............*Syntames*
   Face without central longitudinal keel......*Phaciocephalus*
7. Face distinctly centrally keeled...............*Eocenchrea*
   Face not centrally keeled........................*Cedusa*
8. Media forking from radia one-third from base of tegmen . ...**Cenchrea, *Herpis? *Persis?*
   Media and radia separate from very near base.......... 9
9. Subantennal process present...........................10
   Subantenal process absent 11
10. Vertex and face in profile forming a curve..*Cyclometopum*
    In profile head angular at junction of face and vertex... ....**Lamenia, Thyrocephalus*
11. Vertex and face narrow, subparallel, apex of face narrower than base of clypeus.................**Dawnaria*
    Vertex about as broad as long, apex of face as wide as base of clypeus 12
12. Clypeus triangular, medianally and laterally keeled...... .... *Vekunta*
    Clypeus moderately convex and centrally keeled........ .... **Parandenina*

Goneokara gen. nov.

Type, *pullum.*

Pronotum wider than head. Vertex wider at base than long, base with fine keel, obtusely angularly emarginate; narrowing evenly but slightly to the truncate apex; sides very broadly keeled, studded with wax pits; face and vertex distinctly separated by transverse keel; face slightly narrowed in middle, widening at base, sides deeply keeled, keels with wax pits; clypeus flattened, tricarinate, the lateral ones joining the facial keels; a very small subantennal process; male antennae with second joint globular, a little longer than wide, slightly enlarged toward apex, female antenna smaller and not so globular; pronotum short, broadly angularly emarginate behind, shoulder keels very small; scutellum longer than broad, tricarinate, the lateral carinae fading out on basal half; tegmina fairly short and broad, neuration near to *Cedusa;* granulate on first claval vein and costa. The head and thorax of this is as in *Vekunta*, but the tegmina is very different.

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* Indicates in this and the following tables that I have not seen specimens of the genus.

(1) *G. pullum* sp. nov. (♂ ♀).

Pls. I fig. 21 and II fig. 6.

Vertex, abdomen and notum fuscous brown, face, clypeus, rostrum, legs, and ventral side of thorax lighter brown; tegmina fuscous brown, a small yellowish-white stripe across the apex of costal cell, tips of apical veins whitish; wings fuscous, dark-veined.

Length of body 3 mm.; tegmen 4 mm.

Habitat, Telok Ayer.

Cyclokara gen. nov.

Type, *C. girdlestoni.*

In profile vertex and face forming continuous curve, eyes large, round, slightly emarginate below, antennae small, cylindrical, not reaching to edge of gena, about twice as long as broad; no subantennal process. Vertex small, acutely triangular, base angularly emarginate and keeled, laterally finely keeled; face very narrow, slightly broadening apically below eyes, sides finely keeled, keels contiguous to near apex; clypeus tricarinate; pronotum of medium length, broadly and roundly emarginate behind, medianly keeled, shoulder keels nearly obsolete, a fine transverse carina from middle to the posterior end of shoulder keel; scutellum tricarinate, broader than long, rounded anteriorly, lateral angles behind middle, posterior margin subangular; apex of hind tibae with one large spine on outer and a group or four to five spines on inner side. Tegmina long, apically pointed, second cubitus vein branched, first median sector arising well beyond middle, costa distinctly granulated along basal third. The shape and neuration of this tegmina distinguishes this genus; it comes into the *Basileocephalus* group.

(1) *girdlestoni* (♂) sp. nov.

Pls. II fig. 13, III fig. 4.

Head, thorax, and legs yellowish tinged with red, abdomen red, brightest above, with a black mark in middle of dorsum; genital styles yellow on basal third, black on apical two-thirds; tegmina fuscous, red-veined, a black mark over base of radio-apical and first three medio-apical cells; wings uniformly fuscous, red-veined.

Length, body 2 mm., tegmen 4.5 mm.

Habitat: Mowong. I take the pleasure of naming this little insect after Mr. L. Girdlestone, to whom I am indebted for many kindnesses during my stay at his house at Mowong.

(2) *fulvum* (♂) sp. nov.

Head, thorax, legs, and abdomen dirty yellow, a small black triangular mark on dorsum and a small black dot on each side of abdomen, genital styles pale yellow, eyes deep chocolate brown; tegmina hyaline, opaque with waxy secretion, yellow-veined, irregularly marked with fuscous at base of subcostal cell, continuing over apex of radial cell to hind margin and to apex, all apical cells more or less fuscous, being darkest on the cross-veins from subcostal to third radial vein; wings fuscous, dark-veined.

Length of body 2.2 mm.; tegmen 4.5 mm.

Habitat: Mowong.

Phaciocephalus Kirk.

(1) *flavocollaris* sp. nov. (♂).

Differs from *vitiensis* by its slightly shorter pronotum and less pronounced scutegial carinae. Head, pronotum, tegulae, and legs reddish-yellow; scutellum and the sides of abdomen tinged with red, anal tube fuscous, genital armature yellowish, last tarsus and labial joint fuscous; tegmina fuscous brown, darker at base, veins slightly darkened, a dirty white, transparent spot on costal border at end of costal cell.

Length, body 3.5 mm.; tegmen 5 mm.

Habitat: Tuloc Ayer.

(2) *rattlei* sp. nov (♂ ♀).

Vertex a little longer than type; tegmina as in *pullatus*. Head, body, thorax, legs, and tegmina yellow inclined to salmon; posterior half of tegmina, including clavus, more distinctly salmon, a small fuscous mark at end of subcosta, with a reddish mark behind it, the fuscous mark sometimes running into the salmon-colored streak, making it fuscous; wings white and white-veined. Lateral edges of genital claspers subparallel to near tip, where it becomes spatulate and rounded.

Length, body 4 mm.; tegmen 6 mm.

Habitat: Laloki.

I take the pleasure of naming this pretty little insect after Mr. F. Rattle, with whom I lived during my two visits to the Laloki district of Papua.

(3) *concolor* sp. nov. (♂).

Vertex and tegmen as in *pullatus*. Like the proceeding, but uniformly light reddish-yellow. Besides the absence of the color on the inner half of the tegmen, the male genital claspers separate this species, being longer, widest about one-third from base, where it is produced into an obtuse point on upper edge, and then narrowed to a fine, upward-turned point at the apex.

Length of body 4 mm.; tegmen 6 mm.

Habitat: Laloki.

(4) *funebris* sp. nov. (♂ ♀).

Vertex perceptibly shorter than wide; tegmen peculiar in having the first medial sector forked from near its base. Dorsal aspect dark fuscous brown, ventral aspect and legs yellowish-brown; tegmina and wings fuscous, dark-veined. The whole insect, including wings and tegmina, generally covered with flocculent waxy secretion. Genital claspers short, produced into curved, pointed process on upper distal corner, and into a short round process on lower distal corner.

Length of body 3.7 mm.; tegmen 6 mm.

Habitat: Larat.

Cedusa, Fowler.

Biol. Centr. Amer. Rhyn., vol. I, p. 112, Pl. 11, Fig. 28.

(1) *C. funesta* (type), Fowler, t. c. p. 112.

(2) *C. venosa,* Fowler, t. c. p. 112.

(3) *C. vulgaris* (Fitch).

Poeciloptera vulgaris. Fitch. 1857, Cat. N. Y. Insects.
Lamenia vulgaris. Uhler 1884 and others.

(4) *C. kulia* (Kirk).

Lamenia kulia, Kirk., H. S. P. A. Ent. Bull. 1, p. 400. This species has the face wider at apex than in *vulgaris.*

(5) *C. borneensis* sp. nov. (♂).

Light brown, inclining to yellow on ventral side. Tips of rostrum fuscous; dorsum of abdomen dark brown; eye castaneous; tegmina yellowish, slightly fuscous over apical half, veins slightly darker; wings light yellowish with slightly darker veins. Ventral edge of pygophor truncate, lateral edges slightly convexly curved; anal segment about twice as long as broad, parallel sided, rounded at apex, anus on basal third; styles subquadrate, ventral edge slightly convexly curved, apical edge turned slightly inward, a strong inwardly curved spine on dorsal apical corner.

Length 2 mm.; tegmen 3.5.

Habitat: Teloc Ayer.

This species agrees in neuration and structure of head with *C. kulia,* the only other species at present known from the Malays.

Stal figured his type of *Lamenia* on Plate IV of "Eugenies Resa" in a very careful manner; the neuration is quite distinct and plainly shows that the subcosta and radia are joined, and that the vertex is longer than broad. It is very near to *Thyrocephalus,* Kirk., but until I can examine *L. caliginea* I keep them distinct. *L. vulgaris* can be placed in *Cedusa,* the other American forms I have not examined, *L. kulia* also belongs to this genus.

I am not acquainted with *Herpis,* which Stal synonymized with *Lamenia.* It is possible that it does not agree with my restricted *Lamenia* but with *Cedusa,* in which case these forms will have to be placed under *Herpis.*

Eocenchrea gen. nov.

Type *E. maorica* Kirk.

In profile vertex and face gradually curved, very slight angulation at junction of vertex and face. Vertex about half as long as broad, base and apex nearly truncate, slightly narrowed at apex, excavate in middle, transverse keel separating vertex from face; face laterally angulate and broadest about one-fourth from apex, then narrowing to apex, lateral keels deep, distinct median carina; large subantennal process from angle of face to back of gena; antennae oval, small; lateral ocellus beneath eye; clypeus large, flattened, tricarinate, lateral carinae large; pronotum short, shoulder keels very small; scutellum as long as broad, lateral angles about middle, indistinctly tricarinate, especially the lateral ones. Tegmen with long subcostal cell, four median sectors, the first furcate.

Cencharea dorsalis, West., has a very short subcostal cell and the media arises from the radia about one-third from the base of the tegmina; the figure of this species also shows an antennal chamber formed by the pronotum (shoulder keels being large and the subantennal process absent); therefore *maorica* cannot be included with *dorsalis*. *Lamenia hiva* Kirk. agrees with *maorica*, but the facial keels are not so deep. The presence of the median facial keel also divides this genus from *Cenchre*a or *Lamenia.*

(1) *Eocenchrea maorica* (Kirk.).

Cenchrea maorica Kirk. Proc. Haw. Ent. Soc. II. 2. p. 80.

(2) *Eocenchrea hiva* Kirk.

Lamenia hiva Kirk. H. S. P. A. Ent. Bull. I. p. 404.

Vekunta. Dist.

Temesa, Melich. Hom. Faun. Ceylon. p. 40 Nom. praeocc.
Vekunta, Dist. Faun. Brit. Ind. Rhyn. III p. 287. n. nom.*

This genus was placed by Melichar among the Cixiidae, but was considered by Kirkaldy to be a Derbid. My two species, which conform to Melichar's generic characters and have a similar tegminal neuration, possess a short apical labial joint. The absence of a distinct subantennal process separates this genus from *Thyrocephalus.*

(1) *hyalina* sp. nov. (♂).
Pl. I fig. 7.

Pale yellow; lateral third of scutellum fuscous, darkest on hind margins; dorsum of abdomen fuscous; a round black spot on mesopleura, another on metapleura; tegmina hyaline, tinged with light fuscous-yellow on distal half; dark fuscous over costa, along hind margin a narrow mark from radial cross-vein to apex, apical edge and veins fuscous; wings hyaline, light-veined. Genital style narrow for basal third, then roundly widened to near the truncate apex; one-third from base there is a short thick bilobed process, with small hooks on the lobes and near base, also a small curved spine a little way beyond this process.

Length of body 3.3 mm.; tegmen 4.4 mm.

Habitat: Java.

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* In Mr. Distant's description of this genus I think "face" in the first line should read "vertex" and "vertex" in the fourth line "face."

(3) *badia* sp. nov. (♂ ♀).

Face slightly wider than in *hyalina* and keels not so deep. Dark brown, inclining to black on dorsum; legs, rostrum and antennae yellowish, except the last tarsal and labial joints, which are dark; tegmina dark brown, a small yellowish patch at end of costal cell, reaching from costa to media, with a dark spot in the middle of it; wings brown, dark-veined.

Length of body 2.4 mm.; tegmen 3.8 mm.

Lamenia Stal.

Eugenies Resa, p. 277. Pl. IV fig. 5-5b.

Type *Delphax caliginea* Stal. Öfv. af. K. Vet- Ak. Förh. 1854, p. 246.

Habitat: Taiti.

For reasons stated under *Cedusa,* I have separated this species from such forms as *Lamenia vulgaris.* I consider it likely that *Thyrocephalus* Kirk. will eventually be sunk into this genus.

Thyrocephalus Kirk.

H. S. P. A. Ent. Bull. I. 429. Bull. III 169, text fig. 2.

The type of this genus (*leucopterus*), owing to a defective specimen, was characterized as having a 5-carinate scutellum and so illustrated; it has only a central carina. The tegmen figured in Bull. III has the first cubitus vein abnormally approaching the media (media-cross vein very small), another specimen has it absolutely touching. This genus is near to Stal's *Lamenia* and may be eventually synonymized therewith.

(1) *T. flavo-monile* sp. nov. (♂ ♀).

Pronotum, head, legs and ventral side of thorax and abdomen yellow, scutellum dark brown, distal portion of facial keels, clypeus, mark on metapleura, anterior and middle tibiae and upper portion of obdomen fuscous; tegmina hyaline, slightly opaque, brown veined, the brown spreading out broad toward base of veins, filling most of the clavus; wings hyaline, brown-veined. Tegmina, wings and body covered with white flocculent waxy secretion. Genital style with fairly long, pointed and curved apex; anal segment narrowly rounded at apex.

Length of body 4.6 mm.; tegmen 4.7 mm.

Habitat: Amboina, Ceram, and Larat.

The nymph of this species has a broad face, the sides outwardly curved, narrowest at apex and base, a wide area, about a fourth, along each side being beset with wax pits.

(2) *T. flavo-maculatus* sp. nov. (♂ ♀).

Pl. I fig. 1.

Head, thorax, abdomen and tegmina black or brownish black; legs yellowish, last tarsal and labial joint and two bands on front tibiae fuscous; a yellow spot tinged with red on costa at end of costal cell, wings fuscous, dark-veined; base of tegmina and wings reddish; genial style long, narrow, curved at tip and pointed, apex of anal tube sharply pointed, sides of pygophor produced into a curved point.

Length of body 3 mm.; tegmen 4.6 mm.

Habitat: Laloki.

(3) *T. laratensis* sp. nov. (♂).

Pl. I fig. 3.

Similar to *flavomaculatus*, but yellow spot on tegmina smaller. The genitalia shows that this is quite distinct from *flavomaculatus;* the genital style is longer, thinner and more curved at apex; the anal segment bluntly rounded at apex and the side of the pygophor bluntly produced.

Length of body 2.6 mm.; tegmen 4 mm.

Habitat: Larat.

(4) *T. pseudolaratensis* sp. nov. (♂).

Pl. I figs. 2, 24.

This species is like *laratensis* except for the genitalia, the apex of anal tube being emarginate and the apex of genital style thin and curved.

Length of body 2.8 mm.; tegmen 4.3 mm.

Habitat: Amboina.

(5) *T. croceus* sp. nov. (♂).

Saffron color; pronotum, vertex and tegulae lighter than scutellum; legs lighter than body; last tarsal joint and apex of tibia blackish; face (especially the keels) and dorsus of abdomen fuscous; eyes dark brown; tegmina hyaline, veins pale yellow, the whole thickly covered with waxy secretions, making it opaquely white, subcostal and first and second medial apical cells fuscous; wings white, light veined. Anal tube flattened toward apex, curved downward and emarginate at apex, sides of pygophor obtusely angularly produced, the apex pointed; genital styles straight along lower edge, pointed at apex which is outwardly curved, a spine-like process situated on inner side near base.

Length of body 3.6 mm.; tegmen 4.8 mm.

Habitat: Teloc Ayer.

(6) T. *fuscorostratus* sp. nov. (♂ ♀).

Vertex slightly shorter than in *croceus,* making angle between face and vertex slightly greater; keels on face not so large. Head and thorax dark yellow, facial keels, front of clypeus, margin of tegulae, last labial joint fuscous; abdomen dorsally dark, ventrally light; tegmina hyaline, yellowish, a long triangular fuscous mark in second radial and radio-apical cells, the distal portion of last medial and two cubital veins fuscous, slightly fucous on base of costa and along claval veins; wings slightly fuscous, dark veined. This species is near *croceus,* but the genitalia is distinct, the genital claspers being slightly narrower and the apex of anal segment rounded, with a large downward pointing spine on each side near apex.

Length of abdomen 3 mm.; tegmen 4.6 mm.

Habitat: Telok Ayer.

(7) T. *vitreus* sp. nov. (♂).

Facial keels fairly deep, perceptibly converging about middle. Light yellow, facial keels, dorsum of abdomen and last labial joint fuscous; a round black spot on metapleura; tegmina vitreous, claval and distal ends of cubital veins smoky; wings smoky vitreous, dark-veined. Anal segment rounded at apex; genital styles slightly spatulate at end, rounded at apex.

Length of body 2.5 mm.; tegmen 3.8 mm.

Habitat: Roban, Java.

(8) T. *pseudotypicus* sp. nov. (♂).

Pl. I fig. 5.

Head, pronotum, legs and abdomen testaceous, face (especially keels) fuscous; abdomen dorsally blackish; tegmina hyaline, opaquely white through waxy secretion, a fuscous mark in apical subcostal and first apical median cells. This species is very close to the type of the genus (*leucopterus*), but the genitalia is very distinct. A genital style of each is figured as that is the more easily observed part of this structure, but the penis presents more marked differences.

Length of body 3 mm.; tegmina 4 mm.

Habitat: Teloc Ayer.

(9) *T. obscurus* sp. nov. (♂).

Pl. I fig. 6.

Only by the genitalia am I able to distinguish this species from *leucopterus* with any certainty. The anal tube is pointed at apex, the genital clasper is figured.

Length of body 2.5 mm.; tegmen 3.5 mm.

Habitat: Teloc Ayer.

(10) *T. fullawayi* sp. nov. (♂).

Brown; keels of face and vertex and subantennal process lighter brown, antennae, borders of pronotum, legs (except front and middle coxae, which are brown) and metasterna yellow, front and apices of middle tibiae fuscous, pleurae of abdomen yellowish, hind margins of abdominal segments reddish; tegmina brown, costal border and a large spot at end of costa yellow; wings fuscous brown with dark veins; both tegmina and wings more or less covered with white waxy secretion.

Male pygophor truncate on ventral edge, slightly and roundly produced at sides; length of anal segment slightly more than twice the breadth, anus slightly before middle. Widest slightly beyond anus, narrowing to the rounded apex, lateral edges on basal half turned down, roundly produced about middle. Genital styles long and narrow, reaching beyond end of anal segment, apex turned inward and upward, ending in a fine spine; upper edge straight, lower edge straight to near curve where there is a small angular projection; two small projections on inner side near base.

Length 2.7 mm.; tegmen 4.4 mm.

Hab.: Island of Guam. Mr. D. T. Fullaway's collection, no. 1219.

This comes nearest to *laratensis*, but is easily distinguished by the styles being narrower and not drawn out into such long spines at apices and the sides rounded and not so much produced, also by the downward-turned lateral edges of the anal segment being larger.

Cyclometopum gen. nov.

Type *amboinense*.

Vertex and face in profile forming a continuous curve; subantennal process large, circular, attached to gena beneath the antenna; antennae subovate, not reaching to middle of eye; lateral ocelli present; vertex slightly broader at base than long, slightly narrowed at apex, base widely angularly emarginate, with narrow keel, sides with broad keels beset with wax pits; transverse keel dividing face from vertex; face subparallel with large lateral keels beset with wax pits on inner side; clypeus broad at base, tricarinate, lateral carinae very distinct, wider apart at base than keels of face. Pronotum short, widely angularly emarginate behind, shoulder keels very small; scutellum as long as broad, lateral angles about middle, distinctly tricarinate. Tegmina very near to *Thyrocephalus*, the radial cross-vein very short, media with two sectors, cubitus furcate.

This genus is separated from *Thyrocephalus* by the rounded profile of the head and the circular subantennal process.

(1) *C. amboinense* (♂) sp. nov.

Pls. I fig. 25, II fig. 12.

Shiny black, the tip of clypeus, labium and legs yellowish.

Tegmina and wings black, a minute red spot at end of subcostal cell.

Ventral edge of pygophor truncate, lateral edges sinuous, anal segment about three times the length of the width of base, anus a little beyond middle, in profile it is swollen, apex angularly emarginate forming two downward-pointing points; styles long, narrow, subparallel sided, reaching to end of anal segment, dorsal edge slightly curved, ventral edge with small rounded projection about a third from apex, apex forming an inwardly turned point.

Length 2.8 mm.; tegmen 3.6 mm.
Habitat: Amboina.

GROUP II.

1. Media not arising from radia, or arising before forking of subcosta and radia............................ 2
   Media not separating from radia until after forking of subcosta and radia.............................28
2. First median sector arising before apical third of tegmen.. 3
   Median sectors confined to apical third or tegmen, first cubitus often joining second, enclosing second cubital cell‡ 22
3. Forking of subcosta and radia at or before the middle of tegmen (subcostal cell long)........................ 4
   Forking of subcosta and radia beyond the middle of tegmen (subcostal cell short)........................19

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‡ In *Robigus* the first median sector is before the apical third, but it comes into this group.

4. Antennae with first joint well developed and flattened........ *Patara**
Antennae with first joint very small.................. 5
5. Antennae pectinated .... *Devadanda**
Antennae not pectinated 6
6. Genae without subantennal processes.................. 7
Genae with subantennal processes 13
7. Vertex extending well beyond eyes, in profile more or less angular between vertex and face.................. 8
Vertex and face forming curve, not angular or greatly extending in front of eyes................*Pyrrhoneura*
8. Antennae reaching to anterior margin of head or beyond .... *Kuranda*§, *Anotia*†
Antennae not reaching to anterior margin of head...... 9
9. Antennae having one or more "palpiform" appendages at base ....*Otiocerus*§§
Antennae without such appendages...................10
10. Face not spatulate at base 11
Face spatulate at base..................................12
11. Vertex curved and recurved in profile ......*Kampulokara*
Vertex straight or with only one curve ♀ *Phantasmatocera*
12. Vertex slightly narrowed before apex but keels never touching .... ♂ *Phantasmatocera*
Keels of vertex meeting about two-thirds from apex.......... *Swezeyia*
13. With distinct shoulder keels 16
With no, or very light, shoulder keels.................14
14. Head round in profile, vertex not ascending......*Nesocora*
Head in profile with vertex ascending..................15
15. In profile with vertex ascending and curved backward........ *Nesoniphas*
In profile vertex slightly ascending but not curved backward ....*Nesoneura*
16. Subantennal process spatulate, attached to gena by slender stalk..17
Subantennal process not spatulate, attached to gena by broad base 18

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§ *Archa* is placed by Distant near to *Kuranda*.

† My knowledge of *Anotia* is too limited for me to give a character constant in all the species. Amalopota differs from both *Anotia* and *Kuranda* by possessing ocelli.

§§ *O. rubescens* Fowler, is not an *Otiocerus* but the figure and description does not allow me to place it with accuracy.

Triopsis Sign. and *Aulacocephala* Montr. are stated to be allied to *Otiocerus*.

17. Face produced well in front of eyes, antennae small with sensory organs very large .... *Kaha*
Face not greatly produced in front of eyes, antennae larger and sensory organs not very large .... *Nesokaha*
18. Vertex truncate at apex, keels on vertex and face not contiguous .... *Lyricen*
Vertex acutely angular at apex, keels meeting at apex of vertex, contiguous on face to near apex.... *Paralyricen*
19. In profile face not forming angle with vertex...... *Makula**
In profile face forming an angle with vertex............20
20. In profile face very strongly curved, especially on apical half .... *Eosaccharissa*
In profile face not so strongly curved..................21
21. Vertex "angularly widened between eyes"....... *Tapoosa**
Vertex "conically rounded anteriorly"......... *Kamendaka*
Vertex with "its apex angulated".............. *Chaprina**
22. Head projecting in front of eyes twice the length of scutellum .... *Vivaha**
Head not so greatly produced.......................23
23. In profile head produced to an acute angle at point of meeting of vertex and face.............. *Interramma**
In profile vertex and face not acutely angular..........24
24. Antennae large, flat and broad.............. *Leptalcocera*
Antennae cylindrical 25
25. Antennae long, reaching to anterior margin of head..... .... *Deribia**
Antennae not reaching to anterior margin of head......26
26. Vertex very acutely angular, base narrow, head much narrower than pronotum .... *Nicerta*
Vertex not acutely angular..........................27
27. Vertex truncate at apex, broad at base, head nearly as wide as pronotum .... *Megatropis*
Head distinctly narrower than pronotum, lateral margins of pronotum ampliated, costal margin broken by a raised portion at end of costal cell................. *Robigus**
28. Subantennal process present........... *Neocyclometopum*
Subantennal process absent 29
29. Antennae distinctly longer than face........... *Platocera*
Antennae not larger than face....................... .... *Heronax*, **Niphadodite*, **Phra*[‡]

[†] The type of this genus is not in the H. S. P. A. collection and the description does not allow me to locate it with any certainty.

[‡] Distant refers this genus to *Fenuahala* (*Heronax*). My knowledge of it does not permit me to define it.

Pyrrhoneura, Kirk.

H. S. P. A. Ent. Bull. I 434.

The absence of a subantennal process separates this genus from *Nesocora,* and the circular shape of vertex and face in profile distinguishes it from the females of *Phantasmatocera.*

(1) *P. immaculata* sp. nov. (♂ ♀).

Pl. III f. 5.

In profile vertex and face round, subparallel to the margin of the eye. Stramineous; silghtly fuscous across the base of face; tegmina hyaline, slightly opaque with waxy secretion, veins yellowish; wings white, light-veined.

Hind margin of last abdominal segment produced angularly in middle, with a pair of contiguous, blunt, downward-pointing processes at apex. Male pygophor slightly emarginate on ventral edge, rounded slightly on the sides, with a small angular projection from the inside; anal segment long, with anus at apex, a small downward-turned, truncate process beyond anus; a little before middle the sides produced into small angles; styles as long as anal segment, curved along the lower edge, sinuous along upper edge, apex turned upward.

Length 2.5 mm.; tegmen 4 mm.

Hab.: Amboina.

(2) *P. rubida* sp. nov. (♂).

The keels on face contiguous on basal half, thus being nearer to *citharista* than *saccharicida.* Dark red; facial keels, labium and legs yellowish; tegmina uniformly fuscous with red veins, wings higher fuscous with red veins; both wings and tegmina opaque with waxy secretion.

Length 2 mm.; tegmen 3.4 mm.

Habitat: Rewa, Fiji.

Kampulokara gen. nov.

Type *cacnosum.*

Head slightly narrower than pronotum. In profile vertex curved and recurved; face sinuous; pointed at junction of vertex and face; antennae cylindrical, set low down on gena, reaching to top of eye; eye round, slightly emarginate below. Base of vertex wide, roundly emarginate, without keel; sides with wide keels beset with wax pits, vertex narrowing towards apex, which is slightly emarginate; face slightly widening to apex, keels shallow at base, deepening toward apex;clypeus tricarnate, median one obscure; pronotum short, sinuously, angularly emarginate behind; scutellum a little longer than wide, lateral angles slightly behind middle; central carina obscure; lateral carinae well elevated in middle, appearing as two small, longish tubercles. Tegmina differing from *Phantasmatocera* in having the first median section forked and the cubitus simple. This genus comes near to *Swezeyia* and *Phantasmatocera.*

(1) *D. caenosum* sp. nov. (♀).

Pl. II fig. 4, 4a, Pl. III fig. 7.

Stramineous, fuscous mark across gena, lateral portion of pronotum and scutellum, eye black; tegmina and wings hyaline, opaquely white with waxy secretion, white-veined; radia, media and cubitus tinged with black, slightly fuscous in clavus.

Length of body 2.5 mm.; tegmen 3.8 mm.

Habitat: Larat.

Phantasmatocera, Kirk.

H. S. P. A. Ent. Bull. I 430. Bull. III 177.
Arunta Distant, A. M. N. H. (7) XIX 406.
Nesophantasma Kirk. Ent. Bull. III 177.

Kirkaldy erected this genus for two species, *arborea* (type) and *vitiensis;* subsequently he erected a new genus, *Nesophantasma,* for the latter species. I now have two species which agree with *Phantasmatocera,* all the specimens being males, and nine species which agree with *Nesophantasma,* all the specimens being females, two of which agree in all details, except the shape of the head, to *P. arborea* and *P. nigromaculata.* The two species, *lalokensis* and *papuensis,* are only represented by females and the shape of the head is intermediate. I believe that this is a genus with slight sexual dimorphism in the shape of the head and that Kirkaldy was correct in his original decision, which I revert to.

(1) *P. arborea* Kirk. (♂ ♀).

Pl. I f. 10-a.

Arunta rubrovenosa, Dist. A. M. N. H. (7) XIX 406.

(♀) The marking agree with the male. Vertex very slightly narrowing toward apex, sides very slightly sinuous, face subparallel sided, antennae reaching slightly beyond eyes, smaller than in male; posterior margin of last ventral abdominal segment widely angular, the apex produced into two small points, turned somewhat ventrally, in profile angular near base.

(1) *P. nigromaculata* (♂ ♀), sp. nov.

(♂) Face not quite so spatulate at base as in type, antennae longer and flatter, reaching to front of head. Stramineous, a broad fuscous band from base of face, through eye, sides of pronotum and scutellum; clypeus, antennae and apical portion of face fuscous, posterior ventral portions of abdomen fuscous; tegmina opaquely white with waxy secretion, with nine or ten black spots as follows: one in clavus, base of media, middle of cubitus, end of cubitus, base of three median sectors and at base of third apical median cell, the dots spreading out along nerves in some cases; wings hyaline, light-veined, opaquely white with waxy secretion.

(♀) Slightly lighter in color than male; antennae reaching in length beyond eyes; vertex very slightly sinuate along sides, face nearly parallel sided. Posterior margin of last ventral plate roundly produced in middle, finely cleft in center.

Length of abdomen 2 mm.; tegmen 3.7 mm.

Habitat: Larat.

(3) *P. lalokensis* sp. nov. (♀).

Pl. I f. 17.

Vertex narrowing slightly toward apex, face subparallel sided; antennae reaching slightly beyond eyes. In coloration body and head as in *nigromaculata.* Tegmina hyaline, opaquely white with fuscous secretion, veins in apical half tinged with red, fuscous in base of clavus, two spots in cubital cell, fuscous along the sides of media and spreading into apex of subcostal cell, black spot at base of third, and fuscous in last two apical, median cells; wings hyaline, opaquely white with waxy secretion, veins in middle wing red. Hind margin of last abdominal segment widely angular, the apex finely cleft.

Length of body 3 mm.; tegmen 4 mm.

Habitat: Laloki.

(4) *P. papuana* sp. nov. (♀).

Pl. I f. 16.

Sides of vertex more sinuous than in *lalokensis*, face narrower. Color as in *lalokensis,* but darker, the whole abdomen being dark fuscous. Tegmina as in *lalokensis,* but the fuscousness much less diffused. Hind margin of last abdominal segment drawn out into a long broad process in middle, with two rounded contiguous points at apex.

Length of body 2.7 mm.; tegmen 4.2 mm.

Habitat: Laloki.

(5) *P. vitiensis* Kirk. (♀).

Pl. I f. 15.

Phantasmatocera vitiensis, Kirk. H. S. P. A. Ent. Bull. I.
Nesophantasma vitiensis, Kirk. H. S. P. A. Ent. Bull. III.

Vertex shorter than in last four species, very slightly narrowed toward apex; lateral margins of face subparallel; very slightly narrowed toward apex; profile of head squarer than in *arborea,* antennae reaching slightly beyond eyes, yellowish Hind margin of last ventral abdominal plate gradually produced medianly, the apex forming two rounded lobes.

(6) *P. unopunctata* sp. nov. (♀).

Pl. I fig. 12.

In profile head slightly longer, narrower and more ascending than *vitiensis.* Stramineous, faint fuscous mark on gena through eye to lateral angle of scutellum; clypeus and ventral portions of abdomen not fuscous; antennae reaching slightly beyond eye, yellowish; tegminae opaquely white from waxy secretion; veins reddish, especially on apical half, a fuscous mark running longitudinally through tegmen, darkest at base; a black spot at base of second and third apical median cells. Hind margin of last ventral abdominal segment angular, the apex angularly emarginate.

The male I associate with this species has the head very greatly produced, the keels of vertex meeting together before the expanded apex, thus approaching the genus *Swezeyia*; the antennae reach beyond eyes and have the sense organs along the edges dark; the coloration is the same as the female. Male pygophor with a small, angular, lateral projection, anal segment about twice as long as broad, widest at base, truncate at end, anus situated at apex; styles long, reaching slightly beyond anal segment, broadened and curved at apex, with a small emargination on dorsal edge near apex.

Length of body 2.6 mm.; tegmen 4 mm.

Habitat: Amboina.

(7) *P. pallidocornis* sp. nov. (♀).

Pl. I f. 13.

In profile head approaching *vitiensis,* but narrowed anteriorly. Stramineous, antennae of same color, mark on gena to scutellum indistinct ;tegmina hyaline, opaque with waxy secretions, two fuscous marks in cubital cell, along sides of media and apex of sectors, apical cells cloudy, black spot at base of second and third apical median cells. Hind margin of last ventral abdominal plate like *vitiensis,* but not so much produced.

Length of body 2.3 mm.; tegmen 3.3 mm.

Habitat: Larat.

(8) *P. pseudopalidocornis* sp. nov. (♀).

Pl. I f. 14.

I have specimens from Queensland which I can only distinguish from *palidocornis* with certainty by the last ventral abdominal plate, which is more roundly produced, narrower, and the ventral lobes (sheaths) narrower.

Length 2.4 mm.; tegmen 3.5 mm.

Habitat: Queensland.

(9) *P. nigricornis* sp. nov. (♀).

Pl. I fig. 9.

In profile head between *unopunctata* and *pallidocornis.* Stramineous, the dark mark on gena, through eye, to lateral angles of scutellum, plain; antennae dark, beset with darker sense organs; tegmina hyaline, opaquely white with waxy secretions, tinged with yellow on basal half, veins yellowish, anterior half of media and bases of sectors blackish, small black spot at base of second and third apical median cells; wings opaquely white, yellow-veined. Hind margin of last abdominal ventral plate produced in middle angularly, the apex produced into two contiguous, pointed processes, standing out at an angle to surface of plate.

Length 2.3 mm.; tegmen 3.5 mm.

Habitat: Larat.

(10) *P. pseudonigricornis* sp. nov. (♀).

Pl. I f. 8.

This differs from *nigricornis* in having the central half of the last ventral abdominal plate steeply produced and angularly emarginate at the apex.

Length 2.4 mm.; tegmen 3.8 mm.

Habitat: Larat.

(11) *P. ambigua* sp. nov. (♀).

Pl. I fig. 11.

Head in profile near to *vitiensis,* but slightly shorter and broader. Stramineous, fuscous mark on gena, through eye, to lateral angle of scutellum; antenna light, with darker sense organs; tegmina hyaline, slightly clouded and partly opaque with waxy secretion, distal portion of radial, median and cubital systems red, fuscous in clavus, dark spot at base of second and third apical radial cells. Wings opaquely white, reddish veined. Hind margin of last abdominal plate fairly steeply produced in middle, roundly bilobed at apex.

Length of abdomen 2.4 mm.; tegmen 3.5 mm.
Habitat: Larat.

Swezeyia, Kirk.

H. S. P. A. Ent. Bull. I, 430.

(1) *S. laratica* sp. nov. (♂).

Pls. I ff19, 19a, III f. 11.

This species differs from the type (*lyricen*) in having the anterior part of the head in lateral view broader and not upwardly curved; it stands between *S. lyricen* and *Phantasmatocera.* Considering the great range of the shape of head in allied genera, I do not consider it advisable to genericly separate this species, although it differs so considerably from *S. lyricen.* Head, thorax, legs and abdomen stramineous, a fuscous mark across gena, through eye and sides of pronotum, and scutellum; tegmina hyaline, opaquely white with waxy secretion, infuscate down center and on apical cells, a dark mark at base of third apical median cell; wings hyaline, white-veined.

Length of body 2 mm.; tegmen 3 mm.
Habitat: Larat.

Nesocora, Kirk.

H. S. P. A. Ent. Bull. III 172.

(1) *N. crocea* sp. nov. (♂).

Keels on face not contiguous. Saffron, keels of face and dorsum of abdomen fuscous; tegmina hyaline, opaque with waxy secretion; centrally irregularly suffused over greater portion with fuscous, veins yellowish red; wings fuscous, dark-veined.

Length of abdomen 2.3 mm.; tegmen 3.7 mm.
Habitat: Fiji, on sugar cane.

(2) *N. coccinea* sp. nov. (♂).

Keels of face contiguous to near apex (in *fidicina* Kirk. they are not contiguous) scarlet, antennae, clypeus, legs and genital style yellowish; tegmina fuscous hyaline, scarlet-veined, except basal half of subcostal, radia, and radial cross vein, which are white, a dark spot at base of third apical-median cell.

Length of abdomen 2.6 mm.; tegmen 3.8 mm.

I include this species in the genus, although it has the facial keels contiguous.

Nesoneura, Kirk.

Subgenus of Pyrrhoneura, H. S. P. A. Ent. Bull. III p. 171.

The presence of a sub-antennal process, and the shape of head in profile, separates this as a genus from *Pyrrhoneura.*

Nesokaha gen. nov.

Type *piroensis.*

In profile angulate at junction of vertex and face, vertex slightly convex, base of face very slightly concave, then evenly and convexly curved to apex; vertex triangular, roundly and shallowly emarginate at base, which is without keel; sides slightly longer than base, with deep keels meeting at apex, studded with wax pits along edges; face very narrow, keels contiguous to near apex; clypeus rounded, tricarinate at base; antennae about twice as long as broad, sense organs well elevated above surface; subantennal process spatulate, with narrow stalk; gena beneath eyes twice as broad as in front of eyes; pronotum fairly short, angularly emarginate behind, shoulder keels well developed; scutellum about as long as broad, lateral angles about middle, tricarinate on anterior half. Tegmina pointed at apex and ampliated beyond clavus, neuration as in *Kaha,* but with two more apical median veins.

(1) *N. pirocnsis* sp. nov. (♀).

Pls. II f. 7, III f. 13.

Head and thorax dorsally reddish brown, ventrally yellowish, including antennae and legs. Tegmina opaquely fuscous, red veined, which are brightest towards apex of tegmina; some light and more transparent spots in clavus, cubital and median cells, wings fuscous, dark-veined.

Length of body 2.6 mm.; tegmen 4.5 mm.

Habitat: Piroe, Ceram.

Kaha, Kirkaldy.

(1) *K. extrema* sp. nov. (♀).

Reddish brown, upper portion of face reddish brown, lower portion white, semitransparent; tegmina hyaline, fuscous, red-veined, lighter across clavus and middle of median cell; a series of five small, triangular, white marks through apical portion of costal cell, a black mark over bases of second and third apical median cell, wings fuscous, red-veined.

Length of body 2.7 mm.; tegmen 3.7 mm.

Habitat: Amboina.

(2) *K. media* sp. nov. (♀).

Pl. II f. 11.

Head as in *extrema,* but processes on antennae not so long. Reddish brown; genae semitransparent, dark round lower portion of eye, extending as three angular markings to edge of face; clypeus and legs lighter; light streak down middle of scutellum; tegmina fuscous, markings as in *extrema* but darker, wings fuscous, red-veined.

Length of body 3 mm.; tegmen 6 mm.

Habitat: Mowong.

(3) *K. ceramensis* sp. nov. (♂).

Agreeing in structure with type (*perfecta*), head in lateral view not extending so far as in *media.* Upper half of face black, lower half transparent; clypeus and apex of face black, antennae light yellow; pronotum and scutellum reddish-brown with broad yellowish mark over keels; legs and genital styles yellowish, abdomen fuscous; tegmina and wings as in *media.*

Length of body 1.8 mm.; tegmen 3 mm.

Habitat: Ceram.

Paralyricen gen. nov.

Type *jepsoni.*

Head in profile projecting in front of eye, subovate in outline; antennae short, elongate ovate, about twice as long as broad; subantennal flange large, stretching from back of gena to near facial keels; eye broader than deep, emarginate on lower edge. Vertex projecting beyond eyes, narrow, acutely angular, hind margin roundly emarginate with fine shallow keel, sides evenly converging to apex where the deep lateral keels meet; face very narrow, keels contiguous from base to near apex; clypeus slightly longer than face, flattened, distinctly tricarinate; pronotum very short, perpendicular in middle, shoulder keels very large, forming very complete antennal chamber, posteriorly deeply angularly emarginate in middle; scutellum slightly longer than wide, the lateral angles slightly behind middle, without carinae or with three very obscure carinae (three light marks on some specimens look superficially like distinct carinae). Tegmina as in *Lyricen,* a little broader in proportion to length. *Lyricen* differs from this genus in having a subparallel-sided vertex with a truncate apex, lateral keels of face never contiguous, face widening from vertex to below eyes, then subparallel; clypeus conspicuously flattened on sides, long and narrow in front, distinctly tricarinate.

(1) *P. jepsoni* sp. nov. (♂ ♀).

Pls. II f. 10, III f. 9.

Head, body and legs light yellow, fuscous on gena in front of the dark brown eye; tegmina and wings hyaline with white veins, sometimes suffused with fuscous over apical cells, both opaquely white with waxy secretion. Hind margin of last abdominal ventral plate of female angularly produced, the side of the produced portion being evenly and concavely curved and starting from the lateral angles of the plate. Male genital styles narrow, sinuous, subparallel sided, rounded at apex.

Length of body 3 mm.; tegmen 5 mm.

Habitat: Fiji. I take the pleasure of naming this little insect after Mr. F. Jepson of Fiji.

(2) *P. knowlesi* (♂).

Head, body and legs reddish-yellow, three distinct carinae on scutellum, tegmina yellowish hyaline with darker veins, wings hyaline with yellowish veins; tegmina and wings slightly opaque with waxy secretion. Male genital styles evenly curved along edge, roundly expanded on apical two-thirds of upper edge, with a small round emargination about middle, apex pointed.

Length of body 2.5 mm.; tegmen 5 mm.

Habitat: Fiji. I take the pleasure of naming this little insect after Mr. C. H. Knowles of Suva.

Eosaccharissa Kirkaldy.

An. Soc. Ent. Belg. LI. 126.

Type *E. Javana* Kirk.

I cannot find the type of this genus among Kirkaldy's collection, but my specimens of *javana* were taken in Java on sugar-cane and conform to his description. I have recharacterized the genus and figured the head of *laratica*.

In profile vertex flat, projecting slightly beyond base of face; face curved slightly at base, more strongly at apex; vertex angular, sides with wide, slightly curved keels, beset with wax pits, base roundly shallowly emarginate, unkeeled; face between eyes narrow (keels contiguous), thence widening; antennae less than the length of an eye, largest at apex; clypeus rounded, laterally carinate at base; pronotum short, deeply angularly emarginate behind; shoulder keels very small; scutellum longer than broad, lateral angles behind middle, tricarinate. This genus differs from *Kamendaka* in having its vertex projecting slightly beyond base of face and the apex of face strongly curved.

(1) *E. javana* (♂ ♀).

Habitat: Pekalongan, Roban, Piroe and Amboina, on sugar-cane.

(2) *E. laratica* sp. nov. (♂).

Pl. I f. 18.

Stramineous, fuscous on gena round ocellus and on dorsum of abdomen; eyes dark castaneous; tegmina hyaline, opaquely white with waxy secretion, apical portion of veins yellowish, light yellow spot in clavus, another at base of radia, a band from apex of clavus to base of first median sector, a spot in middle of costal and subcostal cells, all more or less obscured by waxy secretion; wings hyaline, opaquely white with waxy secretion, dark-veined.

Length 3 mm.; tegmen 3.8 mm.

Habitat: Larat, on sugar-cane.

(3) *E. obscura* sp. nov. (♀).

Stramineous, fuscous on clypeus, ventral portion of thorax and abdomen; front tarsi and marks on tibiae and femora fuscous; tegmina hyaline, opaquely white with waxy secretion, veins yellowish, a light yellowish mark over base of radial and medial cells, apical half of tegmina suffusely light yellow, first and second median apical cells fuscous; wings hyaline, opaquely white with waxy secretion, dark-veined.

Length: 2.5 mm.; tegmen 3.8 mm.

Habitat: Larat, on sugar-cane.

It is possible that this is the female of *laratica*.

(4) *E. sordida* (♂) sp. nov.

Antennae smaller than in *laratica*. Stramineous, legs lighter; fuscous band across gena to the castaneous eye; tegmina dirty brown, lighter along costal and apical margin, veins slightly darker; wings fuscous, dark-veined; wings and tegmina opaque with waxy secretion.

Length 2 mm.; tegmen 3.5 mm.

Habitat: Pekalongan, on sugar-cane.

Kamendaka, Distant.

Faun. Brit. Ind. Rhyn. III p. 310.

(1) *K. australis* sp. nov. (♀).

In profile vertex slightly ascending, keels on face contiguous basal two-thirds; tegnina pointed at region of first three apical median veins, otherwise agrees structurally with description of type. Stramineous, reddish on vertex and on clypeus; eyes reddish-brown; tegmina hyaline slightly opaquely white with waxy secretion, veins yellowish, irregular stramineous markings from costa across base of radial cell to hind margin, broad along the hind margin and over the apical portion of radial cell, fuscous in subcostal, radial-apical, second, third and fifth median apical cells and two black spots in costal cell; wings hyaline, white-veined, opaquely white with waxy secretion.

Length 2.5 mm.; tegmen 4.0 mm.

Habitat: Cairns, on sugar-cane. (Perkins and Koebele coll.)

(2) *K. javana* sp. nov. (♂).

In profile vertex slightly shorter than *australis*. Face very narrow but keels not contiguous. Stramineous; dorsum of abdomen slightly fuscous, eye castaneous, tegmina hyaline tinged with yellow, which is mostly confined to posterior half, a round black dot in third median apical cell.

Length 2 mm.; tegmen 3 mm.

Habitat: Java, on sugar cane.

(3) *K. versicolor* sp. nov. (♂).

Vertex slightly more ascending than in *australis*, angulation of vertex with face more acute, face very narrow but keels not contiguous.

Stramineous; dorsum of abdomen fuscous also across anterior coxae; tegminae hyaline, opaquely white with waxy secretion, yellow-veined, irregular stramineous, markings in base of claval, middle of medial, middle of costal, and radial cells, apex of medial and claval cells, also across apical portion of tegmina, black marks in two of the radial-apical and two of the medial-apical cells and some irregular fuscous markings on the stramineous bands.

Length 2 mm.; tegmen 3.3 mm.

Habitat: Amboina, on sugar-cane.

(4) *K. amboinensis* sp. nov. (♂ ♀).

Pale yellow; in male the dorsal surface of abdomen fuscous; vertex and basal portion of facial keels fuscous, reddish patch on gena between base of face and eye; tegmina hyaline, opaquely white with waxy secretion, veins yellowish, a fuscous mark through middle of costal and apex of radial and medial cells, a dark spot in apex of clavus.

Length 3 mm.; tegmen 4.6 mm.

Habitat: Amboina, on sugar-cane.

This species is somewhat like *spectra* Dist., but the first and second median sectors arise very near together, and the apex of the tegmina are angularly produced from first to fourth apical median veins.

Nicerta, Walker.

Jour. Lin. Soc. London I 159, pl. 8, figs. 5-5a.

(1) *N. cruenta* sp. nov. (♀).

In profile head conically produced in front, slightly ascending. Head much narrower than pronotum; vertex long and narrow, base roundly emarginate, without keel, sides deeply keeled, meeting at apex; face very narrow, composed of contiguous keels which do not part at apex; clypeus shorter than face, well rounded, without carinae, labium shorter than clypeus, reaching to hind coxae; antennae cylindrical, slightly constricted in middle, extending slightly beyond eyes. Tegmina long and narrow, costal, radial and median cells long, extending along two-thirds of the tegmen, forking of cubitus beyond middle, three median sectors in apical fourth of tegmina.

Yellow, eye reddish-brown, red streak across gena, genae around antennae and antennae tinged with red, an irregular blood-red streak across base of tegmina, another across middle of clavus to cubitus, through middle of costa to media, two small spots on basal half of costa, a spot at base of first median sector, and several small red marks in apical cells; wings hyaline, opaque with waxy secretions, yellow-veined.

Length 3.7 mm.; tegmen 6 mm.

Habitat: Amboina.

This appears to come near to *N. fervens,* Walker.

Megatropis nov. gen.

Type *coccineolinea.*

In profile head semicircular to oblong, gena wide or very wide in front of eye. Head slightly narrower than pronotum, vertex broad at base, roundly emarginate, without keel, apex truncate, half the width of base, sides straight, evenly converging to apex, with deep keels, beset along edge with wax pits; face narrow, parallel sided to apex, keels of vertex continued down sides of face, the edge of the keels sometimes touch one another but are not contiguous at their bases; clypeus shorter than face, wide at base and rounded, very obscurely tricarinate; labium (beyond clypeus) half as long as clypeus. Antennae cylindrical, simple, with a round projection, or a distinct prong, at base, distally notched or slightly bilobed where arista is articulated; pronotum very narrow, shallowly and widely emarginate behind, median portion fitting into the emarginate vertex; scutellum slightly broader than long, lateral angles a little before middle, anteriorly rounded, posteriorly angular. Tegmina about four times longer than broad; subcosta and radia forking before the middle, cubitus forking about same distance from base, three median sectors in apical third of tegmen, end of clavus beyond middle of tegmen.

I separate this genus from *Nicerta* on the width of the head, vertex and face, also on the nature of the facial keels. It may represent some species of Walker's *Interamma,* but as I am unable to recognize his forms I shall consider Melichar's *I. rubrofasciata* as the representative of that genus. Of the genus *Deribia* I only know *D.* (*Anotia*) *coccinea* Guer. through Cuvier's Iconog. and Girard's Trait. d'Ent.

(1) *M. coccineolinea* sp. nov. (♂ ♀).

Fig. Pls. II f. 2, III f. 14.

Uniformly very pale yellow, eyes dark brown, a tinge of red on gena in front of eye; tegmina hyaline, opaquely white with waxy secretion, a crimson line from base to apex through middle of tegmen, anterior apical margin tinged with red; wings hyaline opaquely white with waxy secretion. Antenna reaching slightly beyond eye, cylindrical, slightly constricted in middle, without any projection or fork at base.

Length 3.8 mm.; tegmen 6 mm.

Habitat: Mowong.

(3) *M. immaculata* sp. nov. (♀).

Structurally agreeing with type. Pale yellow, eyes brown, gena tinged with red before eye, tegmina and wings hyaline, opaquely white with waxy secretion, tegmina tinged with yellow, yellow-veined. Hind margin of last ventral abdominal plate roundly and bluntly produced.

Length 3.3 mm.; tegmen 5.4 mm.

Habitat: Amboina; Teloc Ayer.

(3) *M. pallida* sp. nov. (♂ ♀).

Antennae a little longer than head, a very short prong, or big tubercle, projecting from the base. Hind margin of last ventral plate of female angularly produced, centrally depressed or lipped (like on a jug). General facies as in *immaculata*.

Length 3 mm.; tegmen 5 mm.

Habitat: Teloc Ayer.

(4) *M. flexicornis* sp. nov. (♂).

This has the general facies of the last two, but the prong of the antennae is nearly as long as the main branch, the two forming a horse-shoe-shaped organ. The genitalia separates it from the male *pallida*, the genital styles being narrower and the anal tube produced into a blunt, ventral, median process.

Length 3 mm.; tegmen 5 mm.

Habitat: Pontianak.

(5) *M. rubella* sp. nov. (♀).

Head much more produced in front than in the type, prong of antennae two-thirds the size of main branch, lying alongside of it. Vertex, upper portion of gena, middle of pronotum and scutellum, tinged with scarlet. Hind margin of last ventral plate roundly produced.

Length 4 mm.; tegmen broken.

Habitat: Amboina.

Only one specimen with tegmina in bad condition.

Leptaleocera gen nov.

Type *coccinea.*

In profile vertex and face forming two curves; eyes long and narrow, the hind margin being deeply emarginate; edge of face subparallel to edge of eye. Vertex narrow and angular, base roundly emarginate, without keel; sides with very deep keels meeting at apex; face linear, keels contiguous right up to apex; clypeus about as long as face, rounded, obscurely carinate in middle, no lateral carinae; labium short, about one-third the length of clypeus; antennae large, flat, thin, slightly thickened round edges; pronotum very short, projecting well into excavated vertex; scutellum about as long as broad, rounded anteriorly, obtusely angular behind, lateral angles behind middle, no carinae. Tegmina long and narrow, subcosta and radia forking well beyond middle, subcostal cell small, cubitus forking before middle, four median sectors in apical third of tegmina, last one very small.

(1) *L. coccinea* sp. nov. (♂).

Pls. II f. 5, III f. 15.

Thorax, legs and abdomen reddish-yellow, eyes black; tegmina and wings scarlet, some darker and more opaque spots in cells between end of clavus and subcostal cell, also in apical median cells.

Habitat: Teloc Ayer.

Length of body 3.7 mm.; tegmen, 5.4 mm.

Heronax, Kirkaldy.

H. S. P. A. Ent. Bull. I 431.

Fenuahala, Distant. A.M.N.H. (7), XIX 411.

(1) *H. parnassius* Kirk. (♀).

This species, which is the type of the genus, has the base of face slightly convex, the point of junction of face and vertex angulate in profile. Hind margin of last abdominal ventral plate of female obtusely angular, the sides of the production starting from lateral margin, slightly sinuous, apex finely pointed and turned upward, finely grooved from apex to near basal margin, the anterior styles long and finely pointed. Until I know the shape of the last abdominal ventral plate and the profile of the head of *H.* (*Fenuahala*) *infuscata* Distant, I cannot accept Kirkaldy's synonymy of it with *parnassius.*

(2) *H. saccharivora* Kirk. (♀).

This species has the vertex somewhat elevated but there is no angulation between vertex and face; the last abdominal ventral plate produced angularly in middle half, without groove down middle; anterior genital styles shorter and not so pointed as in *parnassius.*

(3) *H. lalokensis* sp. nov. (♂ ♀).

Head in profile with vertex and face forming one curve, antennae nearly as long as head, broad, flattened. Male genital styles about three times as long as broad, subparallel sided, slightly angular in middle, apex with small, curved point, anal segment with a downward curved point at apex; sides of pygophor acutely angularly produced. The last abdominal ventral plate of female with hind margin widely angularly produced, with a deep medial groove down apical third. Stramineous; tegmina and wings hyaline with yellow veins, subopaque with waxy secretion; two circular broad yellowish bands across tegmina, the first passing over the median crossvein and the other over the bases of second and third median sectors; irregular yellowish spots in apical cells and on basal third.

Length 2.3 mm.; tegmen 5.4 mm.

Habitat: Laloki.

Platocera gen. nov.

Type *annulipes.*

In profile head conically projecting at junction of vertex and face; vertex ascending, face gradually curved; gena at middle of face about half the width of an eye. Vertex narrow, acutely angular, base roundly excavate, not keeled, keels along lateral margins deep, meeting at apex, beset with wax pits; face very narrow, keels contiguous to near apex; clypeus large, rounded, obscurely tricarinate; antennae very large, flat, thin, subequal in width throughout, truncate at apex, conspicuously angularly bent at base, forming a disk-like base at right angles to distal portion; pronotum very short, no shoulder keels; scutellum distinctly shorter than broad, lateral angles situated behind middle, without carinae. Neuration of tegmina near *Heronax,* first median sector leaving media at junction of media and radia. *Niphadodite* Kirk. was founded upon a unique which is missing from the collection. It appears to be near this genus, especially to *nigrofrons.*

(1) *P. annulipes* sp. nov. (♂).

Pls. II f. 9, III f. 3.

Stramineous, fuscous along sides of face and apex of clypeus; front and middle legs with two black rings on tibiae, and a black streak down femora, hind legs with apex of femora black; apex of labium black; tegmina hyaline with yellowish veins, a broken fuscous mark across tegmina about middle of clavus and another, less broken, at first median sector; a series of fuscous marks in costal cell, apical veins fuscous.

Length 2.3 mm.; tegmen 3.7 mm.

Habitat: Amboina.

(2) *P. nigrifrons* sp. nov. (♂).

Antennae not quite so large as *annulipes,* narrowed at base and apex, the basal disc not being so large, appearing more as a swelling at base; media with four sectors. Face, antennae, clypeus, ventral aspects of thorax and abdomen and sides of pronotum and scutellum fuscous, legs, vertex, median portion of pronotum and scutellum and dorsal aspect of abdomen fuscous yellow. Tegmina hyaline, slightly opaque with waxy secretion, yellowish veins spotted with black, the black spreading into cell in clavus, and at base of second median sector; wings hyaline with yellowish veins, slight opaque with waxy secretion.

Length 2.3 mm.; tegmen 5.4 mm.

Habitat: Larat.

Neocyclometopum gen. nov.

Type *sordidum.*

In profile vertex and face rounded, the apical portion of face being slightly flattened; subantennal flange rising from round the base of antennae, large and foliaceous; antenna subtriangular, just reaching to eye. Vertex acutely triangular, base fairly broad, roundly, shallowly emarginate, without keel; lateral keels deep, obscurely beset with wax pits, converging towards apex and continuing down face, where they are contiguous for some distance; clypeus slightly larger than face, flattened, especially at sides, obscurely tricarinate; pronotum very short, perpendicular in middle, widely, angularly emarginate behind, shoulder keels large; scutellum about as wide as long, lateral angles well behind middle, without carinae. Tegmina near to *Platocera*, but with four median sectors, the median cross-vein joining media slightly before the forking of radia and media.

(1) *N. sordidum* sp. nov. (♂).

Pl. II fig. 3.

Antennae flattened, subtriangular, attached to head at one of the angles, the edge grooved, appearing as if the antenna was composed of two plates. Dirty yellow, genae, antennae, clypeus and lateral portions of pronotum fuscous, scutellum fuscous with three indistinct yellowish longitudinal marks, ventral aspect of abdomen fuscous; genital styles yellow; tegmina hyaline, with irregular markings along veins, several fuscous spots in costal cell; wings dirty hyaline, dark veined; both tegmina and wings semiopaque with waxy secretions.

Length 3 mm.; tegmen 6 mm.
Habitat: Larat.

(2) *N. borneoensis* sp. nov. (♂ ♀).

In profile gena not so wide as in *sordida,* face not so flat in profile, antennae conical, widest at base, a little longer than wide. Fuscous yellow, face, antennae, legs and basal ventral portion of abdomen fuscous; tegmina and wings hyaline, yellow-veined, slightly opaque with waxy secretion, tegmina reddish along costa.

Length 2.5 mm.; tegmen 5 mm.
Habitat: Mowong.

GROUP III.

1. Subcosta and radia contiguous to near their ends, subcostal cell very short or absent, eyes in front reaching to the base of the clypeus 2
   Subcostal cell long, sometimes very narrow, eyes in front not reaching to base of clypeus 4
2. Antennae flat, as long as from apex of vertex to end of scutellum ....*Muiria*
   Antennae not so long 3
3. Radial cell reaching to middle of tegmen or beyond, very narrow . ...*Leomelicharia*
   Radial cell not reaching to middle of tegmen, not very narrow ....*Sikaiana*
4. Shoulder keel large, subantennal process present..*Zeugma*
   Shoulder keels not large, no subantennal process....... 5
5. Antennae large, longer than face...................... 6
   Antennae not longer than face......................... 8

6. Antennae cylindrical .... *Zoraida*
   Antennae flat 7
7. Scutellum without carinae .... *Peggia**
   Scutellum with three carinae .... *Peggiopsis*
8. Head as wide, or wider than, pronotum .... *Philadelphia, Fescennia*?*
   Head not as wide as pronotum 9
9. Face centrally carinate .... *Pamandanga**
   Face not centrally carinate 10
10. Head in profile projecting angularly in front of eyes .... *Jada**, *Helcita*?*
   Head in profile not projecting angularly in front of eyes .. 11
11. Clypeus rounded, carinae indistinct 12
   Carinae on clypeus very distinct 13
12. Subcosta and radia forking at or beyond middle of tegmen .... *Diostrombus*
   Subcosta and radia forking before middle of tegmen .... *Camma**
13. Face slightly widened apically (carinae diverging), tegmen truncate at apex .... *Afaka**
   Face with carinae contiguous to apex, tegmen not truncate at apex 14
14. Face longer than clypeus; five median sectors, first furcate .... *Phenice**
   Clypeus longer than face 15
15. Media with five or six unbranched sectors .... *Proutista*
   Media with six sectors, the third furcate .... *Paraproutista*

Sikaiana Distant.

A. M. N. H. (7) XIX p. 398.

Mr. Distant suggests that this genus may be allied to *Basileocephalus,* but apart from the tegmina, which places it in a different section of the *Derbidae,* the pronotum alone would separate it very distinctly. *Muiria* and *Leomelicharia* are very closely allied to it. None of the species that I place in this genus have carinae on the clypeus.

(1) *S. fulva* sp. nov. (♀).

Head, thorax and abdomen light stramineous fuscously mottled, legs lighter; tegmina vitreous, iridescent, costa red, broken up into minute spots by small patches of wax; veins brown, red towards apex, a small brown streak across extreme base, another across costa and radial cells a little higher up, a larger mark through middle of costal and radial, and apex of median, cells, continued as a hairstreak to hind margin, a hairstreak through costal and radial cells near apex, apical veins bordered with fuscous brown, leaving white spots in middle of cells; wings very short reaching hind margin of second abdominal segment, truncate at apex, large anal area with stridulating surface.

Length 1.5 mm.; tegmen 3.4 mm.

Habitat: Larat.

(2) *S. straminea* sp. nov. (♂ ♀).

Head, thorax and abdomen stramineous, eyes dark castaneous; tegmina hyaline slightly opaque; veins yellowish, costa and apex of subcosta, radia and media reddish, irregularly and faintly fuscous along veins; wings reaching nearly to end of abdomen, costa with apical half emarginate causing angulation in middle, apically pointed; anal area large with stridulating surface.

Length 1.5 mm.; tegmen 3.8 mm.

Habitat: Larat.

(3) *S. caenosa* sp. nov. (♀).

Thorax, legs and dorsal surface of abdomen dirty yellow, head, antennae and ventral surface of abdomen darker, eyes dark castaneous; tegmina hyaline, iridescent, veins yellowish, fuscous spot at base of first median sector, a small one near base of media and another on second cubital vein; wings about three fourth length of abdomen, costa strongly angular a little before middle, apical half narrow, apex rounded, anal area large, with stridulating surface.

Length 1.5 mm.; tegmen 3.8 mm.

Habitat: Larat.

(4) *S. nigrimaculata* sp. nov. (♀).

Dirty yellow; head, pronotum and three longitudinal marks on scutellum lighter, abdomen with darker brown markings, eyes castaneous; tegmina hyaline, slightly opaque, a round black spot at base of first median sector, wings a little longer than abdomen, costa slightly angular one third from base, apical portion as broad as base, apex subtruncate with black spot in middle of apical area.

Length 1.5 mm.; tegmen 3.8 mm.

Habitat: Larat.

(5) [*S. clymene* sp. nov. (Kirk.)

Pale luteous, the antennae and the mesonotum laterally rather darker. Beneath, and the legs, testaceous, extreme apex of the hind tibiae blackish; extreme apex of the antennae fuscous. Tegmina hyaline, iridescent, veins pale yellow, three percurrent transverse, ashy yellowish, narrow bands (two on the basal third, one just apical of the middle), also two not extending to the middle of the tegmina interiorly (between two and three, and three and the apex), the radial and median veins are also the same color on their apical two-thirds, and the apical veins are all more or less similarly suffused; costal vein pale, speckled closely with sanguineous. Wings hyaline, veins yellowish.

Length 1½ mm.; expanse about 10 mm.
Habitat: Larat (Muir).

G. W. K.]

Loemelicharia gen. nov.

Type *rufovittata*.

Head in profile with vertex flattened and face curved, face projecting very slightly in front of eyes, gena of equal width all round eyes, eyes large, reaching to apex of face, deeply emarginate behind; antennae large, slightly flattened, constricted about middle, indented at side of apex where the arista arises. Vertex triangular, base nearly as wide as length, angularly emarginate, keeled; sides keeled, keels meeting at apex; face very narrow, keels contiguous to apex, clypeus short, broad, rounded, without keels; labium very short; pronotum long, roundly, broadly and shallowly emarginate behind, with median carina; scutellum distinctly shorter than broad, lateral angles well behind middle, hind margin very broadly angular. Tegmina near to *Sikaiana,* but the median basal cell is very narrow and reaches to middle of tegmina or beyond, the median cross-vein parallel to media, and the subcostal cell is absent; wing very small, with stridulating surfaces on anal areas. In the male genitalia the dorsolateral margin of the pygophor extending as two large, broad spines, much longer than the genital styles.

I have taken the liberty of naming this genus after Dr. Leopold Melichar.

(1) *L. rufovittata* sp. nov. (♂ ♀).

Head, thorax and abdomen bright red; legs, posterior edge of scutellum and post scutellum yellowish; tegmina vitreous; iridescent, costal, radial and median cells red, apical veins red, apical portion of tegmina black, continuing along media as narrow black mark to median cross-vein, a black mark at the forks of cubitus; wings red, very minute, not reaching to hind margin of second abdominal segment, triangular in shape, with large stridulating anal area. In this species the narrow median cell extends two-thirds from base of tegmen.

Length 2 mm.; tegmen 5 mm.

Habitat: Larat.

(2) *L. fuscovittata* sp. nov. (♀).

Pl. III f. 12.

Head, antennae, scutellum, abdomen and anterior half of pronotum fuscous, posterior half of pronotum and the postscutellum yellowish, legs yellowish; tegmina hyaline, iridescent, a fuscous band from base, along costa, covering the costal, radial and median cells, and extending round to past the second cubital vein; apical veins red; wings fuscous, in shape and size as in *rufovittata.*

Length 2 mm.; tegmen 5 mm.

Habitat: Larat.

Zeugma Westwood.

This has a neuration near to *Zoraida*, the cubitus having four veins and the media eight sectors, the first, furcate, sector being joined to cubitus, the cross-veins of cubitus and first two media sectors contiguous at end after which they are a short distance apart (gradate), subcosta and radia separate from a little before middle of tegmina, subcostal cell narrow, radia with five small branches in upper fourth of tegmina; the face and vertex forming one curve, broad and parallel sided; antennae pyriform, pointed end forming apex, and attached to head by the side and not by the center of larger basal end; subantennal process present, narrow, attached more behind than under antenna; pronotum long, shallowly and roundly emarginate behind, shoulder keels large and, together with subantennal processes, form distinct postantenal cavities. This is the only genus of this group which possesses subantennal processes and shoulder keels.

Z. monticola sp. nov. Kirk.

[Head, pronotum, sterna and legs orange-yellow, the two latter more obscurely; a small spot at the base of the tegmina and another close to the hind angle of the mesonotum, blackish; labium, abdomen (mostly), basal and apical third in fore and of middle tibiae, apex of hind tibiae, third segment of tarsi, etc., more or less fuscous. Tegmina hyaline, tinged with cinereous, a fuscous line covering cubital and median cross veins, another over media and a third through subcostal cell to apex, a black line over apical cross veins.

Length 4.5 mm.; tegmen 9 mm.

Hab.: Parit Buntar (Malay Peninsula), Mowong and Pekalongan (Muir).

This may possibly be Westwood's *Z. vittata,* the locality of which is unknown, but he omits all mention of the conspicuous spots at the base of the tegmina and on the mesonotum; and the antennae are shaped quite differently, so much so, in fact, that if I did not think Westwood's description and figure of them (the antennae) erroneous, I should have founded a new genus on that character alone. G. W. K.]

The pygophor produced on ventral edge into a small median rounded projection, the side into a broadly triangular plate, with pointed apex reaching nearly to apex of genital style; anal tube large, slightly longer than genital styles, anus about one-third from base, apex angularly emarginate; genital styles long and narrow, slightly broader at base than at apex, apex with sharp point turned upward and inward. Hind margin of last abdominal plate of female evenly and widely emarginate in middle, the lateral portion of margin being slightly raised above median portion.

Zoraida Kirk.

Thracia Westwood, preoc.

This genus apparently has four or five cubital veins, and four sectors to the media; the first sector, which has two branches, appearing as belonging to the cubitus.

(1) *Zor. superba* sp. nov. (♂).

Antennae longer than face, cylindrical, sense organs small, light-colored. Posterior median edge of pygophor produced into small triangular plate, a little longer than width of base, sides produced into small angles, not half as long as genital style; anal tube very long, reaching beyond styles, anus about one-third from base, apex wide, deeply, angularly emarginate; basal fourth of genital styles narrow, apical three-fourths wider, convex outside, apex truncate with an inwardly curved spine on lower apical angle.

Head, thorax and abdomen reddish-brown, keels yellowish, pronotum and abdomen beset with small light-colored tubercles, legs and genital organs yellowish; tegmina uniformly brown except the narrow costal, subcostal and basal half of radial cells which are light yellow, veins reddish, the three veins entering truncate apex with a faint dark spot at base of the small whitish tips, cross veins slightly fuscous; wings reaching to first median sector, fuscous, reddish-veined.

Length 5 mm.; tegmen 13 mm.

Habitat: Laloki.

(2) [*Zor. sylvicola* sp. nov. Kirk.

Head and appendages, sterna, sternites, and legs, orange-yellow, the fore and middle tibiae and tarsi more or less fuscous, except at the extreme base. Nota pale piceous, the pronotum and keels of mesonotum darker, the mesonotum paler, the elevated margin of the mesonotum, metanotal keels, etc., pale. Urotergites, pygophor, etc., black. Tegmina and wings hyaline; veins dark brown or black; costal, subcostal, radial, and median veins (but not the forks of the latter), suffusedly sooty, the suffusing broadening near the apical margin, so as to occupy nearly one-third of it. Some of the other veins are sometimes a little suffused. Pronotum scarcely granulate. Antennae cylindrical, sense organs medium sized, light colored.

Length 3 mm.; tegmen 11.5 mm.

Habitat: Telok Ayer (Muir). G. W. K.]

Ventral edge of pygophor angularly produced in middle, base of produced part narrower than length; sides broadly, angularly produced, the rounded apices reaching about the middle of anal tube; anal tube slightly longer than broad, anus near base, apex roundly truncate; styles not reaching to end of anal tube, ovately spatulate, slightly convex on upper side. Last abdominal ventral plate of female slightly wider than long, hind margin broadly, angularly produced from sides to middle; and tube about as broad as long, anus near base, sides convexly curved, apex deeply, angularly emarginate.

(3) *Zor. pseudosylvicola* sp. nov. (♀).

Yellow, light on ventral side, inclining to brown on dorsal side, especially on abdomen. Tegmina hyaline, brown-veined, the tips of the four veins entering apical margin colorless, subcostal and radial cells brown. This is the same coloring as in *sylvicola* but lighter.

The median fourth of the posterior edge of last ventral plate produced into a broad, bluntly-pointed process, its width at base about half its length; anal tubes not reaching to end of styles, lanceolate, anus near base. The production on last segment and shape of anal tube separates this species from *sylvicola*.

Length 3 mm.; tegmen 11.5 mm.

Habitat: Telok Ayer.

(4) [*Zor. insulicola* sp. nov. Kirk. (♂ ♀).

Head and nota brownish-testaceous, keels paler. Antennae, sterna (mostly), legs, etc., pale yellowish-testaceous; antennae cylindrical with closely set brown-ringed sensory organs. Pronotum with many pale granules. Mesonotum smudged with fuscous near the base. Abdomen brownish-testaceous, closely speckled above with purplish-brown or black. Tegmina with fine cubital veins, hyaline, so closely suffused with fuliginous that they have the aspect of being fuliginous, minutely spotted with hyaline (principally along the veins); apical half of costal parts clearer, nevertheless spotted with fuliginous; veins crimson. Wings hyaline, veins fuscous. Sometimes the tegmina are more or less maculate with black at the base, along the costal area, and apically.

Length 4.25 mm.; tegmen 10 mm.

Habitat: Amboina (Muir). G. W. K.]

Ventral edge of pygophor cordately produced in middle the pointed end apical, and, in lateral view, base swollen; sides very slightly and roundly produced; anal tube of medium length, anus behind middle, in dorsal view sides to anus parallel, then gradually tapering to pointed apex, which is curved downward, in lateral view of even width to turned down apical portion, which is thin; genital styles not quite as long as anal tube, narrow at base, the broader apical three-fourths with sinuous, parallel edges, apex rounded; last ventral abdominal plate of female longer than broad, moderately angularly produced from sides to middle; anal tube small, little longer than broad, anus near base, gradually narrowed to bluntly-pointed apex, beset with long hairs along edge.

(5) *Zor. cydista* Distant.

A. M. N. H. (7) XIX 402.

Two females from Laloki which agree with the description; the white of postscutellum and dorso-central abdominal mark is due to waxy secretion. Antennae cylindrical with fine light-colored sense organs. Last ventral abdominal plate longer than broad, gradually and slightly produced in middle; anal tube reaching about half way along styles, little longer than broad, ovate in outline, anus near base, with a small process from middle of previous dorsal plate projecting over base.

One male from Amboina also agrees with these, but the yellow is more reddish, the markings on tegmina lighter and the antennae slightly longer and more slender. Ventral median edge of pygophor obtusely angularly produced, sides angularly produced as far as middle of anal tube, the ventral edge of angulation about twice the length of the dorsal edge; styles somewhat hatchet-shaped, base narrow, upper edge straight, apex broadly truncate, ventral edge deeply and roundly emarginate at base, with a deep cleft half-way along the broad apical part; anal tube reaching to end of styles, narrow, bluntly rounded at apex, anus about middle.

(6) *Zor. fuliginosa,* sp. nov. (♀).

Antennae long, cylindrical, beset with small, light-colored sense organs. Length of anal segment about twice the width of the base, narrowed on distal half, apex roundly pointed, anus near base, a small truncate, median process from anterior dorsal plate projecting over base; last ventral abdominal plate slightly and evenly produced; the lateral portion of the anterior styles produced into an acute point. Fuliginous, pronotum and abdomen lightly irrorate, keels of head and scutellum and the legs yellowish tegmina fuliginous, dark-veined, except costa, distal half of subcosta, radia and apical tips of median veins, which are yellowish-white; three small white dots in basal half of costal cell, the apical half along with subcostal cell and tips of extreme apical cells white, a minute black dot near ends of radial and first three median veins, all the veins more or less irrorated with white spots along side; wings fuliginous, dark veined. This species comes near *Z. consanguinea* Distant.

Length 4 mm.; tegmen 10.8 mm.

Habitat: Laloki.

(7) *Zor. lalokensis* sp. nov. (♀)

Hind margin of last abdominal ventral plate exceedingly slightly and evenly produced (nearly truncate), plate longer than wide, a transverse depression two-thirds from base, the basal two-thirds convex in middle; a small round process projecting from last dorsal plate over base of anal tube; anal segment ovate, reaching half-way along styles, anus near base; antennae cylindrical, thickly beset with large sense organs. Stramineous, eyes brown, antenna brown, sense organs darker, legs slightly infuscate, ventral part of abdomen, especially the posterior plate, dark fuscous; tegmina and wings hyaline, brown-veined, costal, subcostal and radial cells fuscous yellow.

Length 4.4 mm.; tegmen 12.25 mm.
Habitat: Laloki.

(8) *Zor. laratae* sp. nov. (♂ ♀ ?).

Medio-ventral edge of pygophor produced into small turbinate-shaped process; sides nearly straight; anal segment very long, narrow, with angularly emarginate apex, the apical third turned down, forming less than a right angle with basal two-thirds, anus in middle of basal, unbent portion; styles long and narrow, not quite reaching to bend in anal segment, irregularly spatulate, apex truncate and bent inward, a small conical projection near the base of the lower edge. Antennae long, slightly flattened, with small sense organs. Stramineous, brown eyes, abdominal segments with a few red spots on dorsum, slightly infuscate at base of scutellum; tegmina and wings hyaline, with fuscous yellow veins, costal, subcostal and basal portion of radial cells yellowish, the extreme tips of radial and first three median veins colorless with small spots where the color ceases, a dark mark covering cross-vein in radial cell near apex. I have a female from Amboina slightly lighter in color. In it the last abdominal plate is subtruncate (slightly convex); anal segment slightly longer than broad, broadly rounded at tip, with the anus at base.

Length 3 mm.; tegmen 9.5 mm.
Habitat: Larat; Amboina?

(9) *Zor. javanica* Westwood (♂ ♀).

Medio-ventral edge of pygophor produced into a lanceolate process; sides truncate; anal segment very long, apex acutely pointed, apical third turned down at right angles to basal two-thirds, straight basal portion narrowest at base, with anus in its middle, genital style subspatulate, lower basal edge turned inward, formed into a two-lobed process, apex of right style subtruncate, with the upper corner produced into a long, curved spine, left style with apical spine small and apex more rounded. Antenna as long as head and thorax, cylindrical, thickly studded with small sense organs.

The female I associate with this male has the stramineous portion light salmon red and the fuscous portion much darker, the tegmina and veins also more fuscous. Hind margin of last abdominal segment broader than long; anal segment broadest slightly beyond base, pointed at apex, sides curved, anus near base, the previous segment being produced in middle over the base of anal tube into a small rounded process. Two specimens from Roban, Java.

Peggiopsis gen. nov.

Type *rufus.*

Antennae longer than head and thorax together, flat, upper edge of apex slightly emarginate where seta situated, narrowed at base, margins thicker than disk; vertex and face perceptibly below the level of the eyes, which are round and bulging; clypeus longer than face, narrow, tricarinate. Pronotum and scutellum as in *Zoraida,* the scutellum being distinctly tricarinate. Cubitus furcate, media with five sectors, the first furcate and joined to the cubitus, its base appearing as median cross-vein. Hind tibiae with a minute basal, large sub-apical and one large and three small apical spines. This genus appears to be very near to *Peggia* Kirk. (*Nebrissa* Stal), but the round bulging eyes, sunken face and the distinct tricarinate scutellum distinctly separates it.

(1) *P. rufa* sp. nov. (♂ ♀).

Light red, eyes and tips of genital styles black; tegmina and wings hyaline with reddish-brown veins, costal and lower portion of radial cells yellowish, the narrow subcostal cell fuscous. Ventro-median edge of pygophor produced into a truncate-tipped process, the base nearly twice as broad as tip, the sides slightly sinuous, the base in profile gibbous; anal segment as long as styles, subspatulate, the base being constricted below anus; genital styles very narrow at base, gradually widening to the nearly truncate apex, the upper corner of which is produced into a small rounded process which is turned inward, near the base of upper edge there is a small spine.

Female with last abdominal plate longer than broad, hind margin broadly, angularly produced; between the plate and the genital styles there projects a small conical-shaped plate; anal segment nearly as wide as long, ovate in outline, with a small emargination at apex, anus situated at base. The one female specimen from Amboina has a much deeper emargination at apex of anal segment, and the small ventral plate between last segment and styles is more pointed. I expect the male will show it to be a distinct species.

Length 3.6 mm.; tegmen 9.8 mm.
Habitat: Piroe, Amboina.

Proutista Kirkaldy.

[Mr. Distant has persisted in synonymizing this with *Phenice,* but the two are different. In *Proutista* the clypeus is distinctly longer than the frons; while in *Phenice* the frons is longer than the clypeus, or, at least, not shorter; and the venation of the wing is much simpler in the Aethiopian genus than in the Australasio-Oriental one. Formerly I was willing to adopt Mr. Distant's views, as I have never seen a *Phenice,* and it was possible that the figures of Boheman and Westwood might be somewhat inaccurate, but Mr. Distant's own figures, in the "Fauna of India" and "Insecta Transvaaliensia," drawn by the same careful artist in each case, of "*Phenice moesta*" and of "*Phenice abdominalis,*" show that I was justified in my original contention that *Proutista* is not a synonym of *Phenice.* G. W. K.]

Until I can examine African specimens of *Phenice* I shall retain the genus *Proutista.* It is very distinct from allied genera (excluding *Phenice* which I have not examined) in the reduction of the female genital styles, which are represented by minute tubercles. In this genus the cubitus has two branches and the media five or six simple sectors, the median cross-vein being near base of first sector so that the cubitus appears as three veined and the media to have but four sectors.* Hind tibiae without basal and submedian spine. There is a large group of species of similar facies to *moesta* and *lumholtzi* which will only be finally straightened out by a study of the genitalia. Some of the following species may prove to be synonymous, but I must leave it to those who have the original types to describe or figure the genital organs.

(1) *P. lumholtzi* Kirk.

A. S. E. Belg. (1907) LI 126.

Medio-ventral edge of pygophor produced into a parallelogramical process, longer than broad, the sides and apex being slightly concave, in profile the base projecting; lateral edges slightly rounded ;anal segment long, bent downward at rightangles before the middle, the basal, straight portion subparallelsided, length about three times the breadth, anus one-third from base, the distal bent portion forming a long, finely-pointed spine; styles projecting to bend in anal segment, breadth slightly more than half the length, margins rounded, apex produced into a finely-pointed, inwardly-turned spine, on upper margin near base there is another small spine. Last abdominal plate of female in profile excavate in middle, the medio-basal portion produced into strong, short spine, the posterior edge produced regularly in middle.

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* Westwood's figure of *Phenice fasciolata* shows five median sectors, the first furcate; the costa, subcosta and general shape of tegmina also differ in these two genera.

Habitat: Queensland and Amboina, on sugar-cane.

(2) *P. gemina* sp. nov. (♂).

Similar in markings to *lumholtzi,* the dark markings on tegmina slightly more expansive. Anal segment very small, length about twice the breadth, basal two-thirds parallelsided, then pointed, anus situated in distal third; ventral edge of pygophor truncate; styles reaching slightly beyond anal segment, irregularly diamond-shaped, the broadest part nearest the base, apex forming a small inwardly-curved point. The genitalia differs so greatly from *lumholtzi* that there can be no confusion between them.

Length 2.3 mm.; tegmen 6 mm.

(3) *P. koebelei* sp. nov. (♂).

This has the same markings and general appearance as *gemina,* but the genitalia is very distinct.

Ventral edge of pygophor truncate; lateral edges between style and anal segment produced into triangular plates (subequilateral); anal segment small, projecting very slightly beyond apices of lateral triangular edges, cylindrical, anus situated at apex; styles slightly longer than broad, broadly rounded at apex, upper edge irregularly produced, a small spine on lower edge of apex.

Length 2.5 mm.; tegmen 6 mm.

Habitat: Queensland. Coll. Koebele No. 2270.

I take the pleasure of naming this species after Mr. A. Koebele.

(4) *P. moesta* Westw.

Specimens from Malay Peninsula, Java, Pontianak, Makassar and Amboina agree with the description of this species. The male genitalia are identical in all these specimens. Ventral edge of pygophor truncate, lateral edges slightly curved; anal segment long, bent at less than a rightangle a little beyond middle, straight basal portion with curved sides, broadest about middle, where anus is situated, bent portion narrow, pointed; style reaching to bend in anal segment, length a little more than twice the breadth, edges subparallel, apex drawn out in fine point which is turned inwards, the upper edge near base produced into a small angular process.

(5) *P. javensis* sp. nov. (♂ ♀).

Yellowish-brown; antennae, keels on face and clypeus, middle of pronotum and scutellum, legs and genitalia lighter yellow; tegmina hyaline with yellowish veins, fuscous brown over subcostal and radial cells, four or five small dark marks through costal cell, bases of cubitus and radial sectors fuscous, fuscous over median cell, extending into clavus, a dark mark at apex of cubital veins and at end of each radial sectors, fuscous on each side of gradate cross-veins of media; wings hyaline with fuscous markings over veins. Ventral and lateral edges of pygophor truncate; anal segment about as long as styles, the apical third turned down at right angles to basal portion, which is about twice as long as broad, with the anus about the middle, the apical third narrow, pointed at apex; styles projecting about one-fourth beyond bend of anal tube, narrow, edges subparallel at base, narrowing toward the blunt, round apex, the apical third being cylindrical. Last ventral abdominal plate of female short, a deep, longitudinal depression down the middle, the posterior edges forming two crescent-shaped ridges below the very small genital styles, anal segment minute.

Length 2.5 mm.; tegmen 7 mm.

Habitat: Java.

(6) *P. perkinsi* sp. nov. (♀).

Light brown; face, middle and lateral edges of pronotum, median line on scutellum and sides of abdomen light yellow, dark dorsal portion of abdomen spotted with light yellow, labium and tarsi dark brown; tegmina subhyaline, costa, subcosta and base of media and cubital veins yellowish, rest brown, subcostal and radial cells light fuscous brown, extending at base into clavus, also over apical half of cubitus, tips of median sectors and gradate median cross-veins bordered with fuscous; last ventral abdominal plate angularly produced, apex deeply but narrowly emarginate, deeply, longitudinally depressed along middle and sides, leaving two keels between the depressions, anal segment and genital styles excessively small.

Length 2.7 mm.; tegmen 7.7 mm.

Habitat: Queensland. Coll. Messrs. Perkins and Koebele.

I take the pleasure of naming this insect after Dr. R. C. L. Perkins.

(7) [*P. calypso* sp. nov. Kirk. (♂ ♀).

Pale luteous, more or less suffused with orange; beneath testaceous; sterna and abdomen basally more or less suffused with orange; antennae, labium and legs testaceous; labium and fourth segment of labium, etc., black: apex of hind tibiae, second and third segments of the tarsi, dark fuscous. Tegmina hyaline; radial and median veins, and veins on basal third testaceous, rest fuscous, spotted with fuscous. Wings hyaline, veins fuscous.

Length 2.7 mm.; tegmen 6.3 mm..

Habitat: Larat (Muir). G. W. K.]

Medio-ventral edge of pygophor produced into small angular process, about twice as long as the base is broad; lateral edges rounded; anal segment medium size, constricted slightly before middle, anus situated in middle, bluntly rounded on apex; styles large, in lateral view somewhat boatshaped, the upper edge being nearly straight and produced into a rounded point, the bottom edge rounded, curving up to point, the inner edge of the rounded point being drawn out into a short sharp inwardly turned point. Anal tube of female very small, genital area below tube large and swollen, embossed across middle, genital style exceedingly small, lateral edges of last abdominal segment straight, ventral plate depressed along the middle near posterior border, the edges of the depression slightly projecting behind. In this species the first median sector approaches the cubitus and appears as if belonging to that system, the median cross-vein being very small.

(8) *P. straminea* sp. nov. (♀).

Stramineous; tarsi and tip of labium fuscous, dorso-lateral portion of abdomen brown, spotted with lighter dots; tegmina and wings subhyaline, veins dark brown. Basal median portion of last abdominal ventral plate produced into a blunt point, posterior edge into two flattened processes; lateral edge of last segment produced into a small triangular piece. The two median processes on the last ventral plate are very distinctive.

Length 3 mm.; tegmen 5.8 mm.

Habitat: Laloki.

(9) *P. lurida* sp. nov. (♀).

Stramineous; tips of clypeus, labium, tarsi and hind tibiae fuscous, abdominal segments slightly fuscous; tegmina subhyaline, covered with waxy secretion, veins yellowish, cross-veins fuscous, several narrow brown marks through costal cell, apices of veins fuscous, which slightly extends into the cells; wings subhyaline with brown veins; lateral margins of last abdominal segment produced into a flattened spine with a rounded apex, reaching to end of genital segment; ventral edge not produced.

Length 3 mm.; tegmen 7.7 mm.

Habitat: Laloki.

The approximation of the first median sector to the cubital system is very conspicuous in this species.

(10) *P. lutea* sp. nov. (♂).

Stramineous, dorso-lateral reddish marks down pronotum and scutellum and on pleurae, clypeus and labium fuscous, median keel on clypeus and facial keels yellowish, sides of abdomen fuscous; tegmina light fuscous brown with a broad hyaline patch down apical half, gradate median cross-veins fuscous, small marginal white marks between veins; wings fuscous, yellowish-veined, fuscous cross-veins. Ventral edge of pygophor produced into a small, median, spatulate process; lateral edges sinuous, produced into a small triangular plate beside anal segment; anal segment long, narrow, basal half parallel-sided, apical half thinning to fine point, anus about a third from base; styles reaching to end of anal segment, widened on upper basal half, gradually thinning to fine point at apex which is turned inward.

Length 3 mm.: tegmen 7.7 mm.

Habitat: Laloki.

Paraproutista gen. nov.

Type *ceramensis.*

This genus differs from *Proutista* in the neuration of the tegmina, the cubitus being two branched and the media having six sectors, the third being furcate, the first three angular near their bases, the first one appearing to belong to the cubitus. Hind tibiae with basal, submedian and apical spine, also several smaller apical spines. Female genital styles exceedingly small.

(1) *Par. ceramensis* sp. nov. (♂ ♀).

Pl. III f. 2.

Dark brown; keels on face, antenna, legs, lateral edges and middle of pronotum, keels and posterior edge of scutellum yellowish, a few yellowish spots on abdomen; tips of labium, tarsi and tibiae fuscous; tegmina hyaline greatly suffused with fuscous, veins brown, the subcostal, radial and median cells fuscous, extending across middle of cubitus and fourth and fifth median sectors to posterior border, cubital veins and median sectors irregularly bordered and spotted with fuscous, dark marks in costal cell breaking it up into spots.

Anal segment very small, rounded, shorter than the width of the base, anus at apex; lateral edges of pygophor produced angularly; ventral edge broadly angular; styles attached well within pygopher, little longer than broad, rounded along lower edge and at apex, a small depression along upper edge, with a small angular projection pointing outward near apex. Genital area of female flattened, anal tube very small, styles abortive.

Length: 8 mm.; tegmen 9 mm.
Habitat: Piroe; Laloki.

(2) [*Par. ismene* sp. nov. (Kirk.).

Brownish-yellow; clypeus, labium, pronotum (except down the middle), abdomen in part, brownish piceous; frons, antennae, legs, testaceous; apex of hind tibiae, second and third segments of tarsi, darker blackish. Tegmina dark fuliginous, veins bright sanguineous, hyaline spots all along the costal area on the clavus and along the inferior margin. Wings fuliginous, veins dark fuscous with hyaline spots; hind margin of mesonotum and urotergites basally in part clear luteous. The head-keels are fairly separated basally; third segment of labium short; pronotum not, or scarcely, granulate. Mesonotum greatly declivous, carinae distinct. Abdomen variable beneath, sometimes sanguineous.

Length 3 mm.; tegmen 7.7 mm.
Habitat: Borneo, Moewong (Muir). G. W. K.]

This species stood under *Proutista* in Kirkaldy's manuscript. Ventral edge of pygophor truncate, with a small conical elevation at each corner; lateral edges slightly and roundly produced; anal segment long, anus situated in basal third, which is parallel-sided, apical two-thirds narrow, cylindrical, pointed; length of styles about twice the breadth, straight on the lower edge, bluntly pointed at apex, the basal part of upper edge produced at right angles to main portion. Last abdominal ventral plate of female longer than broad, hind margin produced in middle into angular projection, reaching well beyond end of body, in profile concave in middle, base globose; anal segment very small; styles abortive.

(3) [*Par. antigone* sp. nov. (♂) Kirk.

Castaneous, the keels and the pronotum medially yellower, the clypeus and the abdomen more or less suffused with sanguineous. Pronotum laterally more or less olivaceous, with pale yellowish granules. Antennae, sterna and legs testaceous, leg spines tipped with black, but the tarsi are scarcely at all fuscous; labium and fourth segment of labium fuscous. Tegmina dark fuliginous, bluish-brown basally; costal, subcostal, radial, and median veins, almost entirely dark sanguineous, other veins dark fuscous, in places bluish-black, a few scattered hyaline spots. Hind tibiae with two distinct spines, one at the base. Wings fuliginous, veins black. Clypeal keels very distinct.

Length 3.8 mm.; tegmen 9.0 mm.

Habitat: Telok Ayer (Muir). G. W. K.]

This species stood under *Proutista* in Kirkaldy's manuscript.

Ventral edge of pygophor truncate; lateral edge sinuous, produced into small triangular plate beside the anal segment; anal segment broad on basal two-thirds, the apical third tapering to fine point, anus about middle; styles nearly square, not reaching to apex of anal segment, lower edge straight, apical edge slightly concave, upper edge produced into a large curved process on basal half.

(4) *Par. media* sp. nov. (♂).

Pl. III f. 1.

Light brown; legs, labium and antennae yellowish, pronotum and abdomen with many small yellowish granules; tegmina hyaline, costa, subcosta and radia red, cubitus and median sectors brown; costal, subcostal and radial cells fuscous, costal having a series of white spots, radial with three large ones in upper half, fusciness spreading over apex to tip of fifth median sector; wings hyaline, reddish-brown veins, basally fuscous. Anal segment long, tapering to a point, anus one-third from base; lateral edges of pygophor slightly and roundly produced; ventral edge truncate; styles broadly angular, not reaching to apex of anal segment, lower edge straight, upper edge sinuous, the apex produced into an inwardly-curved spine.

The neuration of this species is of interest, and is perhaps of generic value; the angulation at the base of the first three sectors is very acute and sends a spur backward to join the preceding one, this causes the cubital to appear six-veined, the media to have but three sectors, and as if there were four cross-veins between the median and cubital systems.

Length 4.6 mm.; tegmen 9 mm.

Habitat: Piroe.

(5) *Par. coccineovenosa* sp. nov. (♂ ♀).

Clypeus crimson with fuscous apex, head and thorax brownish-yellow, the legs, keels of face and scutellum and antennae lighter, abdomen crimson; tegmina and wings pale brown with crimson veins, a series of white spots along costal margin, reaching to first median vein. Ventral edge of pygophor truncate; sides narrowly and angularly produced, the apex reaching about middle of anal tube; length of anal segment about three times the width of base, subparallel-sided to near the pointed apex, anus situated in middle; styles as long as the anal segment, the lower edge sinuously rounded on basal half, then concavely curved to the inwardly-turned apex, the upper edge rounded on basal half, then convexly curved to inturned apex. Female styles abortive, a small triangular plate on each side of the minute anal segment.

Length 3 mm.; tegmen 7.3 mm.

Habitat: Malay Peninsula.

Diostrombus Uhler.

Proc. Nat. Mus. U. S. 1896, p. 283.

Drona. Distant. Faun. Brit. India. Rhynchota III p. 305.

Through the kindness of the authorities of the National Museum, Washington, I have been able to examine a female cotype of this genus, and cannot separate it from Distant's *Drona*. The figure of *D. carnosa* (Fauna British India, Fig. 146) I believe to be of a female, and the description of the type of *Diostrombus* appears to be from a female; the male is not likely to possess the forceps-like processes arising from the posterior edge of the pregenital ventral plate.

(1) *D. pennatus* Distant.

Faun. Brit.. India. Rhynchota III p. 306.

I have one female specimen from Java that agrees in all the specific characters with this species; the keels on vertex and face are not nearly so well defined as in *carnosus* or *politus*, and the "forceps" on last ventral plate are much smaller than in the type species.

GROUP IV.

1. Radial and median basal cells subequal in length, ending same distance from base of tegmen................ 2
   Radial and median basal cells not ending same distance from base of tegmen, unequal in length............ 6
2. Face strongly carinate along middle ....*Phaconeura*
   Face not carinate along middle..................... 3
3. Lateral margins of face convex.................*Suva*
   Lateral margins of face not convex................. 4

4. 7 (or 9)* medio-cubito-apical veins 5
5 (or 7)* medio-cubito-apical veins . ... *Nisia*
5. Face not very narrow,, parallel-sided.......... **Kermesia*
Face very narrow, widening at apex.............. **Alara*
6. Veins of cubitus running straight to hind margin...... 7
Veins of cubitus irregular, forming one or more angular cells, sometimes in conjunction with first median sector 8
7. Cubitus 3-4 veined .... *Mysidia*
Cubitus 10-11 veined .... *Derbe*
8. Lateral keels of face contiguous to near apex..........10
Lateral keels of face not contiguous, face not linear.... 9
9. Vertex narrow, about twice as long as broad; in dorsal view keels of face projecting about half the length of eyes .... *Dichotropis*
Vertex as long as broad; in dorsal view keels of face projecting about the length of eyes............. *Decora**
10. No triangular cell at base of first median sector (or radial cross-vein) 12
Triangular cell present at base of first median sector (or radial cross-vein) 11
11. Shoulder keels well developed...................... *Levu*
Shoulder keels not developed .... *Rhotana, Genestia**
12. Face longer than clypeus, eyes reaching below middle of genae . ... *Sumangala**
Face not longer than clypeus, eyes confined to upper portion of genae .... *Mecynorhynchus*

Nisia Melichar.

N. atrovenosa Leth.

There are specimens from Borneo and Piroe which I cannot separate from this species. I am unable to separate this genericly from *Mecnoplus albosignatus.*

Suva Kirkaldy.

Text figures 3 and 3a in H. S. P. A. Ent. Bull. III p. 166 are of *S. koebelei* Kirk., not *Phaciocephalus;* it has one more apical vein than *Nisia.*

Phaconeura Kirkaldy.

(1) *P. laratica* sp. nov. (♂ ♀).

Dirty yellow, abdomen, including genital styles, dark fuscous; tegmina hyaline, broadly bordered with fuscous, the fusciness

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*** Depends upon whether the first forked vein be considered as radial or median.**

being chiefly along second clavial vein, over all the cubital and costal cells, and over all apical veins, leaving the media veins and center of tegmina clearer. Median ocellus present, although small and difficult to see in some specimens.

Length of body 2 mm.; tegmen 2.7 mm.

Habitat: Larat.

There is a single specimen of female in which there is no fusciness on tegmina and which differs slightly in the pregenital segment.

Mecynorhynchus nov. gen.

Type *kershawi.*

Head in profile semicircular, eye in upper half near to vertex, gena in front of eye narrow, below eye broad. Antennae cylindrical, about twice as long as broad, situated on lower part of gena; subantennal processes large, from apex of facial keels to back of gena. Vertex very small, acutely angular, angularly emarginate at base, sides with keels which meet at apex; face very narrow from base to well below eyes, then widening to junction with subantennal processes, thence slightly narrowing to apex, keels large, contiguous to well below eyes; clypeus very long and pointed, the apex reaching third coxae, lateral carinae large, median obscure; labium long, reaching to end of abdomen, distal joint minute; pronotum very short, vertical in middle and fitting into emargination of vertex, hind margin acutely angularly emarginate in middle, shoulder keels large; scutellum broader than long, anterior margin rounded, the rounded lateral angles about middle, posterior median portion angular, without carinae, but a pair of slight grooves run down the anterior third. Tegmina fairly broad, the neuration differs from *Rhotana* in having the subcostal and radial cells longer and broader, the costa evenly curved, not sinuate, the absence of the small triangular cell at the base of first median sector.

M. kershawi sp. nov. (♂).

Pls. II f.f. 1-1a, Pl. III f. 10.

Head and legs stramineous, vertex and face tinged with claret red, eyes brown, pronotum and scutellum fuscous claret, tegmina fuscous, red along costa, veins darker, red at apex. Male genital styles very short, spatulate.

Length of body 2 mm.; tegmen 3.4 mm.

Habitat: Mowong.

I take the pleasure of naming this pretty little insect after my friend Mr. J. C. Kershaw.

Rhotana Walker.

J. Linn. Soc. Zool. I 160.

R. latipennis Walker.

My specimens from Teloc Ayer agree both with Walker's short description and his figures. Shoulder keels slightly developed; subantennal processes large, stretching from the apex of the facial keels, of which they appear to be continuations, to back of gena. *Rhotana vitriceps* Stal does not appear to be congeneric with *latipennis.*

Genestia Stal.

Ofr. Vet. Akad. Forh. XV p. 450 (1858).

The type of this genus, *vitriceps,* cannot be placed in *Rhotana,* but as I only know it by the description and Melichar's figure I cannot separate it with certainty. The neuration of the tegmina, as shown in Melichar's figure, differs considerably from *R. latipennis* Walk.

Dichotropis gen. nov.

Type *amboinensis.*

In profile vertex and face curved, without angulation where they meet; gena in front of eye about half the width of eye, eye about twice as broad as deep, shallowly emarginate on lower border; subantennal process large, the base stretching from facial keels to back of gena; antennae small, barely reaching to eyes, pyriform, the narrow end apical. Vertex small, not reaching to anterior margin of eye, about twice as long as broad, base very slightly broader than apex, acutely angularly emarginate, without keel, sides straight, slightly converging toward apex, keeled, a transverse keel dividing apex from face; face gradually broadening from base to about one-fourth from apex, where the sides are angular and slightly narrowed to apex, lateral keels deep; clypeus about as long as face, distinctly tricarinate, lateral carinae continuous with lateral facial keels. Pronotum very short, hind margin angularly emarginate in middle, shoulder keels large. Scutellum as long as broad, lateral angles slightly before middle, tricarinate. Tegmina having wider radial cell than *Rhotana,* practically the same as *Levu.*

This genus is near to *Decora* Bierm.

(1) *D. amboinensis* sp. nov. (♂ ♀).

Pls. I f. 20, III f. 6.

Stramineous, abdomen slightly fuscous; tegmina and wings hyaline, slightly opaque with waxy secretion, veins yellowish, a fuscous mark on hind margin a little beyond clavus.

Length of body 2.3 mm.; tegmen 4 mm.

Habitat: Amboina (♂ ♀), Larat (♂) and Laloki (♀).

(2) *D. chrysonoe* Kirkaldy.

Rhotana chrysonoe Kirk. H. S. P. A. Ent. Bull. I, 435.

(3) *D. haematoneura* Kirkaldy.

Rhotano haematoneura Kirk. H. S. P. A. Ent. Bull. I, 435.

Levu Kirk.

H. S. P. A. Ent. Bull. I, 434.

Walker's error in numbering the figures on his plate caused Kirkaldy to refer this to *Paricana;* it is related to *Rhotana,* from which it differs in the shorter pronotum, angularly emarginate behind, and the greater development of the shoulder keels, characters which I do not think will hold good with the increase of specific forms.

(1) *L. vitiensis* Kirkaldy.

(2) *L. halosydney* (Kirkaldy).

Rhotana halosydne Kirk. H. S. P. A. Ent. Bull. III, 169. This is typical of *Levu* and if the genus is retained must be placed therein.

(3) *L. amboinensis* sp. nov. (♀).

Stramineous, eyes castaneous; tergmina and wings byaline, subopaque with waxy secretion, veins yellowish; tegmina with fuscous mark from media to cubitus across median cross vein, and another a little beyond to hind margin, a small dark spot at apical fork of radia and media. The structure of head and thorax and neuration of tegmina is typical of genus.

Length of body 2 mm.; tegmen 3.5 mm.

Habitat: Amboina.

(4) *L. sufflava* sp. nov. (♀).

Yellowish, reddish along keels of face; tegmina hyaline, subopaque with waxy secretion. veins on basal half white, on apical half slightly infuscate, a black mark at apical fork of media. The emargination of pronotum is not so deep or so angular as in the type and the branch of cubitus is missing.

Length of body 2.2 mm.; tegmen 4.6 mm.

Habitat: Mowong.

(5) *L. rubra* sp. n. (♀).

This differs from the type in having the vertex slightly flattened, the junction of face and vertex being angular; the pronotum is less angularly and deeply emarginate behind and the tegmina differ in the cubital veins.

Red; the legs and tip of abdomen somewhat paler; tegmina hyaline, red-veined, slightly fuscous along clavus veins; wings hyaline, reddish-veined.

Length of body 2 mm.; tegmen 3.5 mm.

Habitat: Amboina.

(6) *L. laratica* sp. nov. (♂ ♀).

In structure of head and neuration of tegmina this agrees with *rubra*.

Stramineous; keels on face and a spot on gena in front of eye red; tegmina hyaline, veins yellowish, cells besides veins infuscate, especially the transverse veins from radia to cubitus.

Length of body 1.5 mm.; tegmen 3 mm.

Habitat: Larat.

DESCRIPTION OF PLATES.

PLATE I.

1. *Thyrocephalus flavomaculatus,* lateral view of pygophor.
2. " *pseudolaratensis,* " " " "
3. " *laratensis,* " " " "
4. " *leucopterus,* external view of left genital style.
5. " *pseudotypicus,* external view of left genital style.
6. " *obscurus,* external view of left genital style.
7. *Vekunta hyalina,* internal view of left genital style.
8. *Phantasmatocera pseudonigricornis,* ventral view of last abdominal segment of ♀.
9. " *nigricornis,* ventral view of last abdominal segment of ♀.
10. " *arborea,* ventral view of last abdominal segment of ♀.
11. " *laratensis,* ventral view of last abdominal segment of ♀.
12. " *unopunctata,* ventral view of last abdominal segment of ♀.
13. " *pallidocornis,* ventral view of last abdominal segment of ♀.
14. " *pseudopallidocornis,* ventral view of last abdominal segment of ♀.
15. " *vitiensis,* ventral view of last abdominal segment of ♀.
16. " *papuana,* ventral view of last abdominal segment of ♀..
17. " *lalokensis,* ventral view of last abdominal segment of ♀.
18. *Eosaccharissa laratica.* lateral view of head.
19. *Swezeyia laratica,* dorsal view of head and thorax.

19a. " " lateral " " " " "

20. *Dichotropis amboinensis,* front view of head.
21. *Goneokara pullum,* tegmen.
22. *Phaciocephalus miltodias,* tegmen.
23. *Basileocephalus thaumatonotus,* tegmen.
24. *Thyrocephalus laratensis.* tegmen.
25. *Cyclometopum amboinensis,* tegmen.

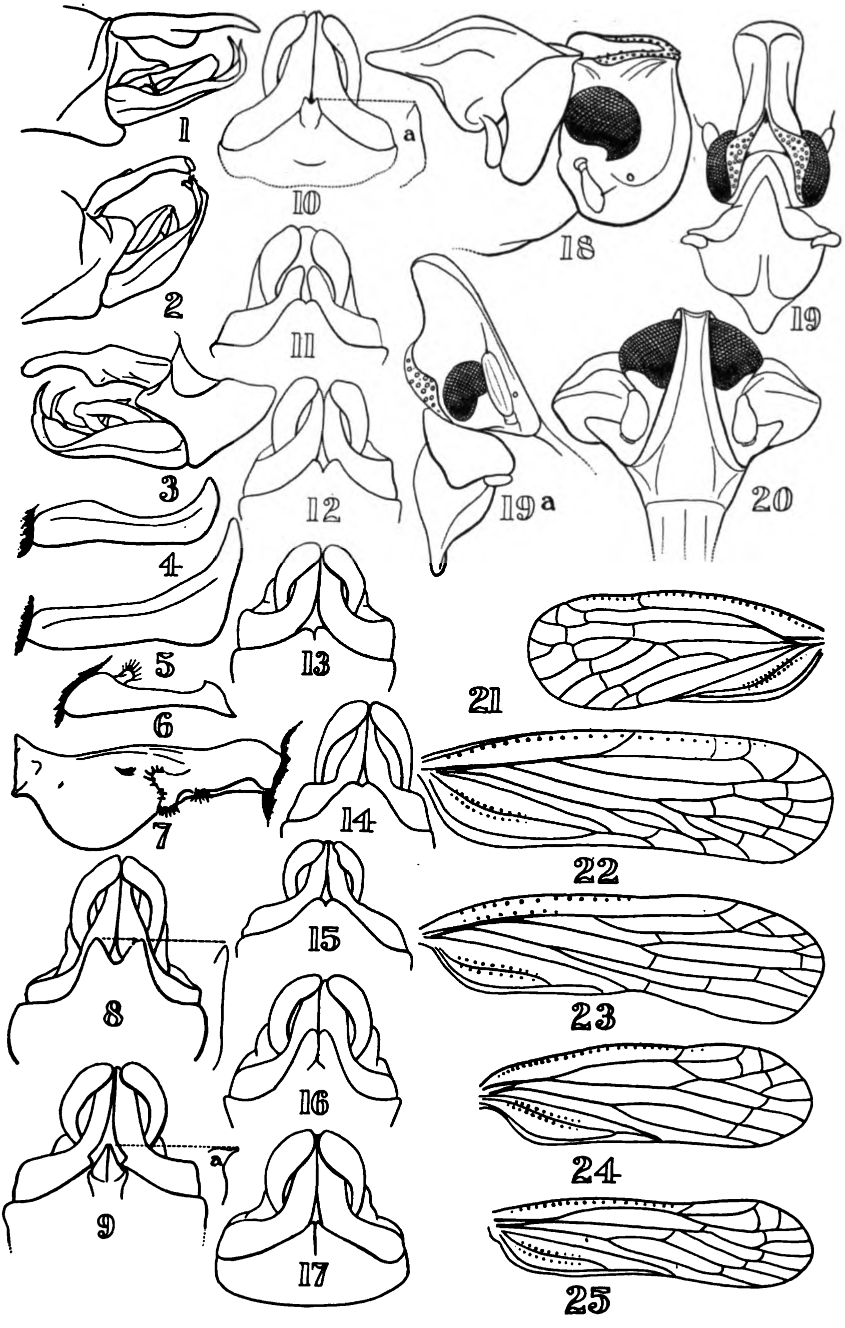


Plate I.

PLATE II.

1. *Mecynorhynchus kershawi,* front view of head.
1a. “ “ lateral “ “ “
2. *Megatropis coccineolinea,* “ “ “ “
3. *Neocyclometopum sordidum,* “ “ “ “
4. *Kampulokara caenosum,* front view of head.
4a. “ “ lateral “ “ “
5. *Leptaleocera coccinea,* “ “ “ “
6. *Goneokara pullum,* “ “ “ “
7. *Nesokara piroensis,* “ “ “ “
8. *Eocenchrea maorica,* front view of head.
9. *Platocera annulipes,* lateral “ “ “
10. *Paralyricen jepsoni,* “ “ “ “
11. *Kaha media,* “ “ “ “
12. *Cyclometopum amboinensis,* lateral view of head.
13. *Cyclokara girdlestoni.* “ “ “ “

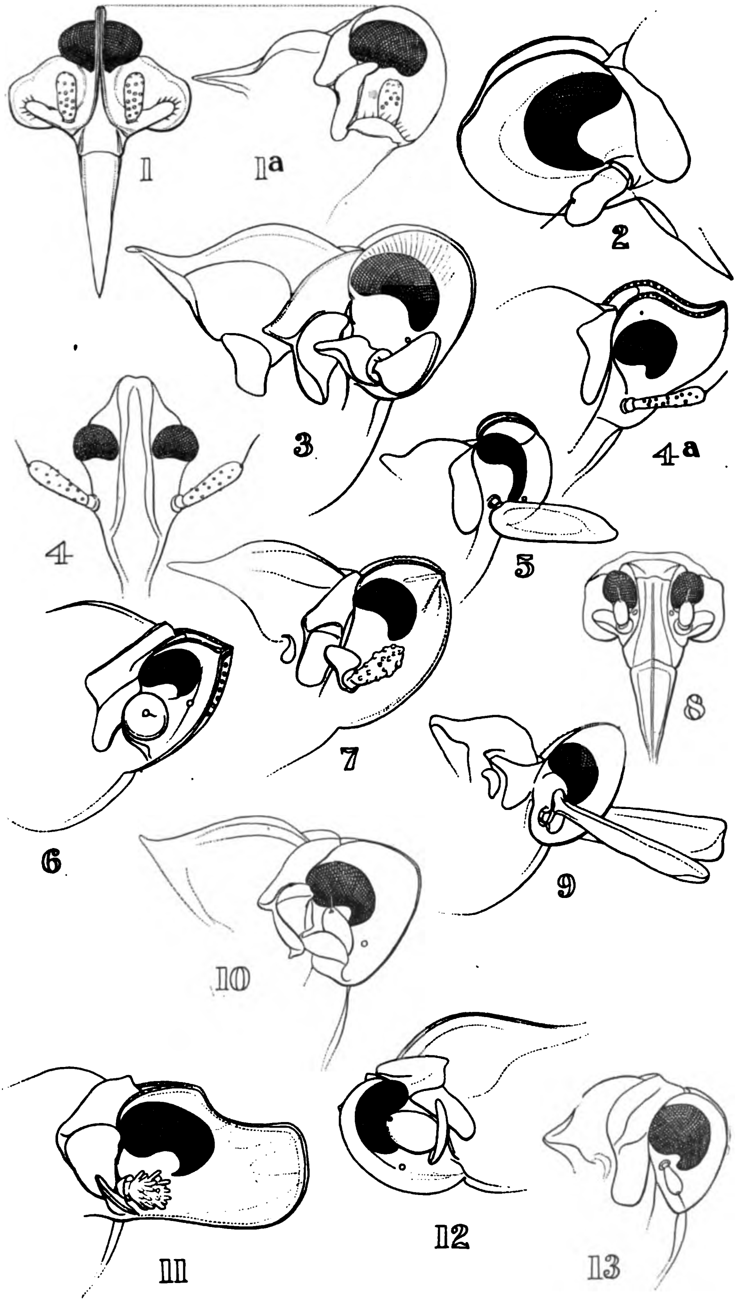
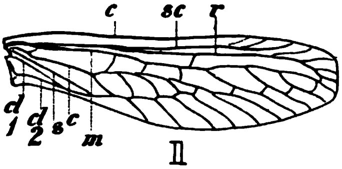


Plate II.

PLATE III.

1. *Paraproutista media,* tegmen.
2. "   *ceramensis,* tegmen.
3. *Platocera annulipes*   "
4. *Cyclokara girdlestoni,*   "
5. *Pyrrhoneura immaculata,*   "
6. *Dichotropis amboinensis,*   "
7. *Kampulokara caenosum,*   "
8. *Eocenchrea maorica,*   "
9. *Paralyricen jepsoni,*   "
10. *Mecynorhynchus kershawi,*   "
11. *Swezeyia laratica,*   "
12. *Leomelicharia fuscovittata*   "
13. *Nesokaha piroensis,*   "
14. *Megatropis coccineolinea,*   "
15. *Leptaleocera coccinea,*   "
16.. *Phaciocephalus pullatus,*   "



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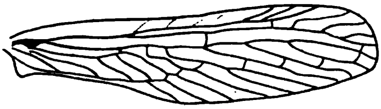

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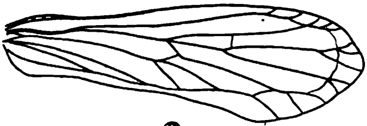

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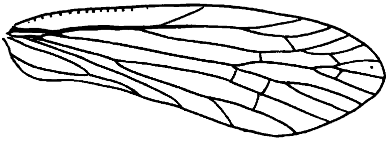

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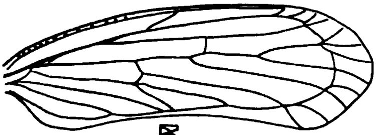

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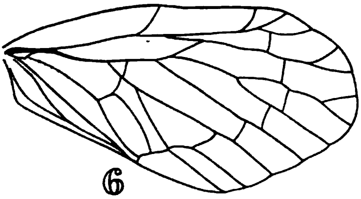

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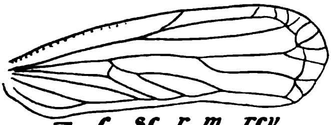

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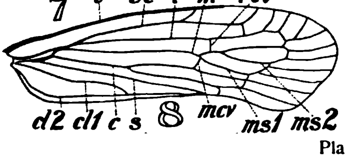

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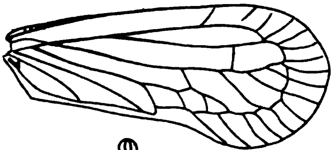

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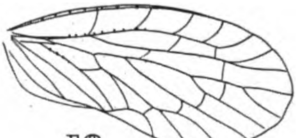

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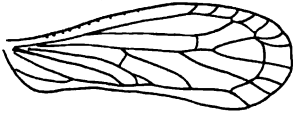

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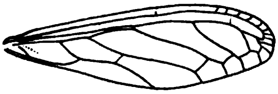

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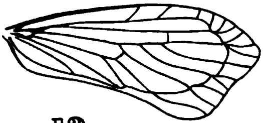

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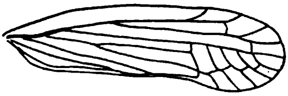

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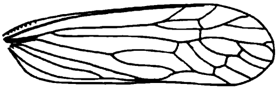

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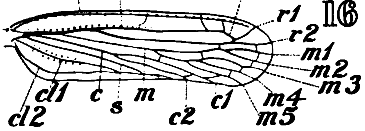

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ENTOMOLOGICAL SERIES BULLETIN NO. 13

REPORT OF WORK
OF THE
EXPERIMENT STATION
OF THE
HAWAIIAN SUGAR PLANTERS' ASSOCIATION

The Cane Borer Beetle in Hawaii and Its Control by Natural Enemies

BY F. MUIR AND O. H. SWEZEY

HONOLULU, HAWAII
SEPTEMBER, 1916

LETTER OF TRANSMITTAL.

To the Experiment Station Committee of the
Hawaiian Sugar Planters' Association,
Honolulu, Hawaii.

DEAR SIRS:—Herewith I submit for publication as Bulletin No. 13, of the Entomological Series, a paper by Messrs. F. Muir and O. H. Swezey, entitled "The Cane Borer Beetle in Hawaii and Its Control by Natural Enemies." The authors have included at my request a number of reports prepared by Mr. Muir while he was actively engaged in the several expeditions connected with this work. These appear as appendices.

Respectfully,

H. P. AGEE,
Director.

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INTRODUCTORY

The work of searching for parasites of the sugar cane borer (*Rhabdocnemis obscura*) and introducing them into Hawaii, described in this Bulletin, extended from 1906 to 1911. The delay in publishing the results is due, first, to the desire to see the final outcome of the work before publishing, which could not be done before 1912-1913, and secondly, to the absence of Mr. Muir on a second trip to the Orient. The delay is not to be regretted as it enables us to state definitely the practical results achieved by the introduction of *Ceromasia sphenophori* into the Hawaiian Islands.

Mr. Muir left Honolulu for the Orient in July, 1906, to investigate the conditions of sugar-cane leaf-hoppers of the genus *Perkinsiella* and, incidentally, to search for the Hawaiian sugar-cane beetle borer (*Rhabdocnemis* (*Sphenophorus*) *obscura*) in those regions. Six months were spent working in Southern China where parasites on *Perkinsiella*[1] were found and forwarded to Hawaii, but *R. obscura* was not found. A similar result attended several months' work in the Federated Malay States and Java.

In Java observations were made on other species of Rhynchophora in banana trees and palms. These observations failed to show any direct parasites, but a number of predators were forwarded to Honolulu. Having failed to discover *R. obscura*, Mr. Muir, in his report from Java in 1907, remarked:

"Two courses lay open before me, viz: to study some allied species and send over parasites I might find upon them, in the hope that they would also attack our borer, or start in search of our borer in some other part of the Malay Archipelago.

"To some extent I had already followed the first course by forwarding some *Histerids* and *Hydrophilids* that prey upon species of *Sphenophorus* in banana and palm trees. To have continued this course would have occupied months of work and probably ended with little or no gain; for parasites are fickle creatures, and, whilst attacking species of distant genera, often refuse to attack closely allied species, as was the case with *Elenchus* and *Perkinsiella vitiensis* and *saccharicida*.

"Rather than do this I considered it would be better to proceed to some spot where our borer is known to exist, such as British New Guinea, where it was abundant some years ago, and is supposed to have been introduced. In this country (New Guinea) native Calandrids are numerous, and if some of their parasites have not by this time transferred their attention to *R. obscura* it is improbable that any chance ones I could send from Java would do so.

---

[1] Some of the material is described in Bulls. Nos. 9, 10, 11 and 12.

"The alternative course, of searching for our borer in other parts of the Archipelago, is such a huge undertaking to carry out thoroughly that I could not contemplate it.

"Before leaving Honolulu I had consulted all the works I could find on the distribution of this beetle, especially in this part of the world. It exists in most of the Pacific Islands to New Guinea and Tenimber, the latter being the most westerly point where it has been taken. I have been unable to get any further information, either from Europe or the Museum in Buitenzorg.

"From Java to Tenimber is such a large field that it would be impossible to thoroughly search even a fraction of it. I therefore decided to try one or two spots, and so work my way to Tenimber Islands, making the search for *Rhabdocnemis obscura* my chief aim, but also studying the death factors that keep allied genera in check."

Following out this plan he first visited West Borneo, spending some time around Pontianak, then visiting Teloc Ayer and other localities in the Kapoeas delta, and afterwards Moewong, in the Mempawah district, seventy miles north of Pontianak and rising three thousand feet above the sea. Although this was only an infinitely small area of the great island, yet it was very varied in character; no trace of *R. obscura* was discovered. Sugarcane is grown in small patches in native gardens and certain patches of "wild" cane of whose existence Mr. Muir had been informed, were visited, but they proved to be old native gardens in which the cane had become feral, as is often the case in New Guinea.

A large Rhynchophora larva in the branches of Pandanus was found attacked by a Tachinid parasite, but it was not likely to be of any use and was not experimented with. Species of the Delphacid genus *Perkinsiella* were present in the cane, attacked by egg-parasites.

Failing to find *R. obscura* in this part of Borneo, and hearing from the Sarawak Museum that the beetle was not represented in their collections, he returned to Java and took ship for the Mollaccas.

Some weeks were spent in Amboina, visiting most of the villages in the company of Mr. J. D. de Roock, Controleur of Amboina, but no trace of *R. obscura* was discovered in the sugar-cane, and the natives did not recognize specimens of the beetle shown to them. A trip to Ceram had been arranged but, owing to an accident to his prospective host, this fell through, and so Mr. Muir proceeded to Larat by way of Kei and Aru Islands.

Prof. H. O. Forbes had taken *R. obscura* in the Tenimber Islands in 1881, and it was considered advisable to investigate its condition there before spending more time in searching for it elsewhere. Five weeks were spent in collecting in Larat and the northern portion of Yamdena; the beetle was found in great numbers in sugar-cane, pinang and sago palms. At this time of the year (November and December) the sugar-cane had been cut and only ratoon stalks remained in the ground, but these furnished ample evidence of the work of destruction of the beetle. In the pinang palm the beetle gets into the soft center of the tree; one old palm which was cut down was infested from root to crown, some forty feet, and must have contained many thousands of empty cocoons. No trace of parasites were discovered, but predators of similar nature to those in Amboina and Java existed in numbers.

With the new knowledge as to the habitats of the beetle in Larat, Mr. Muir returned to Amboina and without loss of time discovered that it existed there in the sago palms, and was attacked by a Tachinid parasite. Thus the first stage in this work was accomplished.

Now began the long and tedious work of trying to transport this small parasitic fly from Amboina to Honolulu alive. At this time there was no line of steamships through the Moluccas to Australia, so that the best means of transport was from Amboina to Macassar, thence to Hongkong and then to Honolulu via Japan. Experiments showed that the fly would not stand transportation in cold storage. Mr. F. W. Terry was sent to Hongkong to receive the material sent from Amboina, and try to breed the fly there, but all ended in failure owing to the connecting boat at Macassar not calling regularly; some shipments were delayed over a month on the voyage. Mr. Muir then decided to take a consignment himself to Hongkong; he managed to keep many flies alive until twenty-four hours from Hongkong, then they died off without any apparent cause. Species of *Histeridae* and *Elateridae* were successfully forwarded to Honolulu.

It now became necessary to return to the Moluccas and discover some other method of transportation, or some other point where the parasite existed from where it would be easier to get it to Honolulu.

In November, 1908, Mr. Muir left Hongkong for the Moluccas, this time having the companionship of Mr. J. C. Kershaw, who had decided to visit and collect in Ceram. A month spent in this island showed that conditions as regards *R. obscura* were similar to those in Amboina. Search for egg-parasites was made, and eggs laid in capitivity were placed in favorable positions, but all hatched without being attacked. Piroe, where Messrs. Kershaw and Muir worked, was very far from being the "zoölogical desert" Wallace had found other parts of this island; among much other interesting material collected here was a new *Peripatus,* the first to be discovered in the Moluccas, and the second in the eastern portion of the Malay-Papuan region.

Before going to Ceram, Mr. Muir had received specimens of *R. obscura* from Mr. A. E. Pratt who, with his son, was collecting around Fak-fak, south west New Guinea; he therefore decided to visit east New Guinea in the hopes of finding both the beetle and its parasite, as from there it could be conveyed more easily to Honolulu via Australia. Leaving Macassar on April 9th, 1909, he proceeded to Port Moresby, Papua. Here he was fortunate enough to meet Mr. F. Rattle, who had a "camp" on the Laloki River, fifteen miles from Port Moresby, where he was conducting experiments in cotton growing. Mr. Rattle kindly invited him to share his camp, which invitation he promptly availed himself of. The camp was situated in the fork of the junction of the Laloki and Goldie rivers. In this district there are many native gardens in which bananas, yam, sugar-cane, pine-apples and other native foods are grown. The sugar-cane is grown in small clumps and tied up to posts to keep it from lying along the ground. The first hour's work in a nearby garden resulted in finding both the beetle and its parasite. It was now decided to stock some cages with the beetle larvae, expose them to the attacks of the parasites, and then transfer them to cages and convey them to Honolulu via Australia. Should the parasites hatch out en route they were to be transferred to another cage and kept alive till they reached their destination. The first part of this program was carried out, but before leaving Port Moresby Mr. Muir contracted fever and upon arriving in Brisbane had to go into hospital with typhoid; his cages were sent forward, but having no one to attend to them all the parasites died before they reached Honolulu. Upon recovering from fever Mr. Muir returned to Honolulu, to spend some time in the mountains regaining strength before returning to Papua, to make another attempt to get this much desired fly into the Hawaiian Islands.

On account of the shortness of the time occupied in the life cycle of the fly, and because it is nearly impossible to breed it in a small cage, the probability of conveying it direct from Papua to Honolulu was considered very remote; it was therefore decided to establish breeding stations in Australia and, if also necessary, in Fiji. Fortunately it was possible to get the services of Mr. J. C. Kershaw to take care of the halfway station.

January 8th, 1910, saw Mr. Muir depart from Honolulu for Brisbane where he had arranged to meet Mr. Kershaw and arrange a place for the erection of large breeding cages. It was first necessary to get the permission of the Union Government of Australia to import their material from Papua, as the quarantine regulations prohibited all such importations. Upon consulting Mr. H. Tryon, Entomologist to the Government of Queensland, he recommended Mossman as a suitable place for the cages, as *R. obscura* existed there in fair numbers; he also wrote to Melbourne explaining the work to be undertaken and recommending that permission should be given to enable the work to be carried out. Thanks to this recommendation the Union Government immediately granted the request. Mr. Muir then left for Papua and Mr. Kershaw for Mossman, bearing letters of introduction from Mr. Tryon to the manager of the Mossman Sugar Mill, and planters in that district.

During his first visit to Brisbane Mr. Muir was shown specimens of diptera puparia in spirit taken by Mr. Tryon from the runs of cane borer in Papua when he was collecting cane varieties in 1895. The flies had not been bred, so their exact host was not known, nor was the adult fly known; Mr. Muir regretted that he did not know of this two years earlier for, slender as the evidence was, it might have saved him much time and labor. A moth borer (*Diatraea striatalis*) is more common than *R. obscura* in the sugar-cane in Papua, and does more damage; its larva is attacked by a Tachinid parasite whose puparia are often found in its runs. All the pupae of this parasite that Mr. Muir collected hatched out hyperparasites, so that he was not able to identify the fly.

A small number of puparia of *C. sphenophori* was sent over to Queensland by post, but they hatched out singly and died before the sexes could be brought together, so nothing came of them. Arrangements were made to take a large consignment of parasitized borer larvae and pupae of the fly to Queensland by the mail boat leaving Port Moresby April 22, but the boat was late and did not leave till the 28th, during which time Mr. Muir was laid up in hospital with malarial fever. Upon arriving at Cooktown the mail boat to Port Douglas, the port of the Mossman district, had departed and no sailing boat would leave on account of bad weather, so he was again delayed five days more. All this time the flies were hatching out and many dying and it looked as if it would be necessary to return to Papua again. At last, on May 5th, Port Douglas was reached, and, a few hours afterwards, Mossman. Mr. Kershaw had three large cages in the field ready, and other smaller ones in the Chemist's laboratory of the Mossman Central Sugar Mill, which had been placed at their disposal. Upon opening up the material it was found that eight adult flies and one hundred and twenty-five unhatched puparia were present; of the latter eighty-three eventually hatched out. Part of the first generation was taken by Mr. Muir to Fiji, where he had arranged with the Colonial Sugar Refining Company to have a cage ready, Mr. Kershaw to follow with the results of the second generation. Mr. Muir had left Papua with malarial fever and had suffered with it during his stay at Mossman; soon after his arrival in Fiji he was obliged to go into hospital, but not before he had placed his flies in an outdoor breeding cage. Mr. Kershaw arrived in Suva on August 9th, bringing with him two lots of cane containing parasitized beetle larvae; one he took ashore, the other he left on board for Mr. Muir to take on to Honolulu in the same ship, along with his material bred in Fiji. Mr. Muir arrived in Honolulu on August 16th. From the material he brought many flies hatched and cages were stocked. Mr. Kershaw arrived in Honolulu a month later with material bred in Fiji. Thus the second stage of the work was accomplished; it now remained to breed and establish the parasite on all plantations affected by the borer-beetle.

It must not be thought that an expedition of this nature is all pleasure. Besides the discomforts and inconveniences inseparable from work in these regions, and the danger to health and even to life, there is the continual monotony of months of unsuccessful search; the monotony of collecting thousands of the same insect and shipping them away, only to learn after weeks of waiting that they have all died en route. The delights of the collecting naturalist in these rich regions, of continually adding to the interest and number of his collection, is greatly lost to the worker on economic lines, for his work keeps him in cultivated regions away from the most interesting and productive collecting fields. It is no easy task for an enthusiastic naturalist, finding himself on the edge of such rich collecting grounds, from which Wallace and so many others have gathered such rich harvests, to resist the temptation to try his luck at collecting. But he must confine himself to the small native gardens and the sago swamps, and his attention to one comparatively uninteresting insect. In spite of resisting this temptation the collections brought back are fairly large and the portions already worked out contain many new species.

It has been stated that sugar-cane is indigenous to Papua; that Papua is the "home" of sugar-cane, and Mr. Muir was informed of "wild" sugar-cane. Every such case that he was able to investigate showed that it was growing on the site of an old native garden, or that it was pieces of cane that had been washed down the river and stranded on the bank and there taken root. Seedlings were found growing in the native gardens, the seed having ripened, fallen and germinated quite naturally. It is very probably due to this natural sowing of its seed, and the germination of seeds in this manner, that has produced the numerous cane varieties in Papua; over two hundred were reported to be grown in the government gardens in 1910, and some of the best varieties grown in Fiji and Australia are native cane from this region. It is because of the number of varieties found in the island that Papua is stated to be the "home" of the sugar-cane.

In judging this question it must be remembered that sugar-cane is of great antiquity in India, being mentioned in some of the ancient writings of that country, and its mythical origin indicates that it belongs to that period, "the twilight of the gods," when agriculture and religion were one. There is even some slight indications that sugar was extracted from the cane in those very ancient times.

From the earliest times there has been streams of migration from the mainland of India, through the Malay Peninsula and the Archipelago, to the most easterly islands of the south Pacific, one stream even going north to Hawaii; over the greater portion of this area the natives carried their sugar-cane. There has been no great migration from east to west, from the Archipelago to the mainland, and it is more probable that the plant passed along with the stream than against it. The time necessary to bring about the present conditions in Papua need not have been very great, for useful plants soon pass into the interior by way of barter.

Mr. A. E. Pratt informed one of the writers that "Irish" potatoes were the chief food of some of the tribes in the Arfak mountains, northwest New Guinea. The early mission at Manokwari had introduced them to the coast tribes who had passed them on to their neighbors; in the low lands they died out, but in the mountains they still thrive. The natural germination of the seed of the sugar-cane would account for the number of varieties, and the isolation of the various tribes from one another would lead to the establishment of varieties in different parts of the country.

The fact that "Fiji" disease is prevalent throughout Papua on sugar-cane might be considered as evidence that cane is a native of that region, but it is probable that the disease will be found to be on other grasses in Papua.

This question is of interest when we come to discuss the original home and food of *R. obscura.*

ACKNOWLEDGMENTS.

When carrying out an expedition of this nature one is indebted to many people for hospitality and assistance. To mention all by name would be a long but pleasant task. Dutch hospitality, both official and private, is well known to those who visit the Dutch East Indies, especially if their visit be connected with scientific work. It is this spirit of hospitality that has made Buitenzorg the Mecca of scientific workers visiting the Malay Archipelago, and is well expressed in the new laboratory recently erected in the Buitenzorg Botanic Gardens for the accommodation of visitors, and aptly named in memory of Dr. Melchior Treub, who for so many years directed the energies of that institution, and who, by the charm of his personality, kindness of disposition, and by his knowledge, personified its spirit.

Mr. Muir did not find this hospitality confined to Buitenzorg, or even to Java, but found it present even in the uttermost parts of the Archipelago, even to Larat, where the government is represented by an Amboinese post-holder. Neither was it confined to government institutions, but such private associations as the sugar planters and large agricultural corporations, as well as private planters, were equally ready to give whatever assistance they could.

In the British colonies, in Papua, Queensland and Fiji, Mr. Muir met with similar assistance and hospitality. In the latter place the representative of the Colonial Sugar Refining Co. erected cages for breeding parasites, and assisted in every way possible, and in Queensland the Mossman Central Sugar Mill placed their services at Mr. Kershaw's disposal.

Another public body to whose services the success of work of this nature so often depends is the shipping companies. Mr. Muir was always fortunate in this respect, for the Pacific Mail, Toyo Kisen Kaisha, Java-China-Japan, the Royal Dutch Mail and Canadian-Australian Royal Mail line, as well as local lines, both

ashore and afloat, were unfailing in their endeavors to assist and accommodate him.

To all these, and to those numerous personal friends who helped to make his expedition a success and a pleasure, Mr. Muir extends his thanks.

There are two other bodies to whom Mr. Muir would like to acknowledge his deepest thanks and appreciation: The first is the Hawaiian Sugar Planters' Association, who, for over two years of fruitless search, gave him their entire confidence and support; the second is that of his colleagues in the Station, especially Mr. J. C. Kershaw, to whose help abroad and successful handling of the material upon its arrival in Honolulu, its propagation and distribution, brought the labors of some four years to a successful finish.

RHABDOCNEMIS OBSCURA (Boisd.)

DISCOVERY AND DISTRIBUTION.

This beetle, which has proved such a pest to the sugar-cane industry of both northern and southern Pacific, was first discovered by D'Urville in New Ireland (New Mecklenburg) during the cruise of the "Astrolabe," and named by Boisduval *Calandra obscura* in 1835, and Fairmaire reported it in Tahiti in 1849; Boheman described the same insect in 1859 under the name of *Sphenophorus insularis* from specimens collected in Tahiti during the cruise of the "Eugenies." In 1885 Blackburn and Sharp recorded this beetle under the name of *Sphenophorus obscurus*, the former having taken it in the Hawaiian Islands, but it was known to sugar planters in these islands long prior to that date; in the same year Forbes recorded it from the islands of Timor Laut. The genus *Rhabdocnemis* was erected by Faust in 1895 for *R. pygidialis* from Burma, and Gahan, in 1900, placed *obscura* into this genus, at the same time describing a new species from Christmas Island under the name of *R. fausti*. The latter species we consider to be a variety of *obscura*.

The geographical distribution of this insect appears to be as follows:

Christmas, Guam, Bonin, Amboina, Ceram, Kei, Timor Laut, New Guinea, New Ireland, Fiji, Samoa, Tahiti, Gambier and Hawaiian Islands, also the northern portion of Queensland. The same, or a closely allied, species is also known from Celebes, Batchian and Mysol Islands.

Judging from our present knowledge it is highly probable that the original habitat of this beetle was New Guinea and the adjoining islands whose fauna indicate a connection with that great area. It is also highly probable that its original food was sago and other palm trees, and bananas. In the Moluccas it is mostly found in sago palms, only one larva being found in sugar-cane during six months' search in Amboina and Ceram. When kept in cages in Amboina with sugar-cane and sago palm it oviposited in the sago. There is reason to believe that sugar-cane was an introduction into Papua due to man, and therefore could not have been the original food of a native insect. The spread of this insect to surrounding islands, and to some of the islands of the South Pacific, can be explained by the fact that it is attached to plants carried about by natives in their wanderings.

That this beetle was introduced from the Southern Pacific to the Hawaiian Islands is highly probable; two varieties of cane, Cuban and Lahaina, were brought from Tahiti to Honolulu by Captain Edwards in 1854, according to the statement of Mr. D. D. Baldwin.[2]

The late Hon. H. P. Baldwin is quoted by Van Dine[3] as having noticed cane damaged by this beetle as early as 1865 in the vicinity of Lahaina, the town after which the imported cane from Tahiti was named, it is therefore possible that it was brought to the islands along with the original importation, or about that period. There is reason to believe that Fiji received it from Hawaii with seed-cane, although it is possible that they received it from Tahiti or some other southern island. Bonin may have received it from Hawaii in seed-cane. Seed-cane sent from Honolulu to Formosa, although inspected before being shipped and again upon arrival in Formosa, was suspected to be infested after it was planted. It was therefore dug up and grubs were found in several pieces of cane. Australia got it from New Guinea in shipments of seed-cane.

The status of the beetle in Celebes is unknown at present, and investigations there may cause us to alter our present ideas.

VARIATION.

Considering the diversity of conditions this insect is known to thrive under the amount of variation is not very great. The chief variation is in color, which varies to a small extent in each locality, but there are also fairly well defined local color races. In Amboina and Ceram the dark markings are of great extent, on the prothorax the median dorsal mark covers the greater portion of the tergite, and on the elytra all the surface, except two angular spots at the base and a smaller pair toward the apex, is dark; in the Larat, New Guinea and Queensland specimens the dark areas are more restricted, whilst in those from Hawaii and Fiji it is still more reduced. In the variety from Christmas Island (*fausti*) the punctures are more distinct and the tomentum denser, characters found also in the Guam specimens.

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[2] The Planters' Monthly, I. p. 42. 1882.
[3] U. S. Dept. Agri., Bur. Ent., Bull. 93, 1911.

Several hundreds of male genitalia were examined, mostly of Hawaiian specimens but also some from other localities, and except for one case no variation could be detected. The exception was a Hawaiian specimen in which the spiculum was forked at the distal end, the normal condition being a slender rod rounded at apex. This specimen must have had a great variation in the musculature as the surface of attachment was more than doubled.

NATURAL ENEMIES.

Plaesius javanus. This Histerid is common in the East Indies, it frequents palms and bananas and finds its chief source of food in the larvae of the various Rhynchophora beetles feeding on these plants. *Cosmopolites sordida* and *Sphenophorus planipennis,* both living in banana trees, are its chief food. A number of these were forwarded safely to Honolulu from Java. The method of transport was to place roots of banana heavily infested with larvae of *C. sordida* and *S. planipennis* in specially built cages with very fine netting on top, back and front; into this was placed the Histerids. The life cycle of this beetle is long and breeding in captivity in great numbers difficult, so they were turned loose into the fields.

None have since been recovered so that apparently they have not established themselves.

This predaceous beetle has lately been introduced from Java to Fiji to prey upon *C. sordida,* the banana borer. Mr. F. Jepson,[4] the Entomologist in charge of the work, gives some interesting figures as to the amount of food devoured by the larvae and adult beetles. It was found that the larvae fed more freely in darkened cages than in the light, an average of 33.8 Rhyncophorus grubs being devoured by each *javanus* per day in the dark, and only 11 in the light; the adult beetle devoured on an average 8 grubs per day. Although so voracious Mr. Jepson found that the adult beetle could undergo long fast (128 to 148 days) if kept in moist soil; in this manner he contrived to get 3792 out of 5000 beetles alive from Java to Fiji. The final result of this introduction has not yet been published.

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[4] Bulletin No. 7, Department of Agriculture, Fiji, 1914.

Platylister abruptum. This is a very much smaller Histerid, very common in the Moluccas in sago, bananas and other places where Rhynchophora larvae are plentiful. On account of its smaller size it was considered more likely to be of use in sugar-cane fields than *P. javanus.* Consignments in cages were sent from Amboina to Hongkong via Macassar, where Mr. Terry received them, and after adding new food forwarded them to Honolulu via Japan. Many of these arrived in good condition and were turned into the fields; some larvae were recovered more than a year after by one of the writers, but since then they have not been seen. Conditions in the cane fields are not suitable for these beetles, but judging by a similar case we should not be surprised if these were eventually found to be established. The case in point is that of *Hister bimaculatus* sent to Hawaii in 1909 by Mr. Koebele to assist in keeping down "horn fly"; after being turned loose they were lost sight of but turned up in stable manure in 1913, and have since been found abundant and widely spread.

Simodactylus sp. This Elaterid beetle was abundant in Amboina, Ceram and Larat in the sago and pinang palms infested with *Rhabdocnemis* on which they fed.

They appeared to be more especially fond of the pupae and many cocoons were found bearing the characteristic round holes made by them in entering the cocoon. Some were bred in Honolulu but the length of the life cycle made breeding in any numbers difficult and so they were turned into the field. They have not been seen since, but as they are so very similar to the common *S. cinnamomeus* that they may remain in small numbers without being detected.

Another predator found in both palms and bananas was the larva of a small Hydrophilid; this fed upon Rhynchophorous larvae, but was more attached to dipterous larvae.

Chrysopila sp. The larvae of this fly were quite numerous in some sago palms and banana trees feeding on beetle and dipterous larvae. *Chrysopila ferruginosa* was found by Jepson feeding in banana trees on *Cosmopolites sordida* and *Sphenophorus planipennis,* mostly on the latter.

Ceromasia sphenophori Villeneuve. This Tachinid was the only direct insect parasite discovered upon *R. obscura.* It was first discovered in Amboina, and afterwards in Ceram and Papua. It was described by Dr. Villeneuve[5] in 1911 from specimens forwarded by one of the writers to Dr. de Meijer; these specimens were bred in captivity and came from the same host so there is exceedingly small chance of there being more than one species, and the variation pointed out by Dr. Villeneuve is not likely to be specific.

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[5] Wien. Ent. Zeit., XXX, p. 81, 1911.

Copulation takes place any time during the first four days. In small cages Mr. Muir observed them mating soon after maturing, the male attaching himself for a few seconds to the back of the female. Several females were caught just after this short union, but in no case had fecundation taken place and the eggs did not develop. In Papua mating took place early in the morning, later in the day the flies were seldom seen freely on the wing.

The female reproductive organs consists of a pair of ovaries about 1.8 mm. long (consisting of 8 to 12 ovarian tubes), two short slender oviducts and an exceeding long common egg-passage. From the junction of the oviducts to the opening of the three small spermathecae and two glands the egg-duct is slender, beyond that point it becomes very large and about 20 mm. long, and forms a uterus. In the recently hatched or unfertilized female this large membranous chamber is in a collapsed condition, numerous fine tracheae being attached to the outer walls; after fertilization the eggs begin to pass into the uterus and there remain until it is quite full, the uterus then being greatly distended and forming three or four complete whorls like an univalve shell. In the distal portion there is only one row of eggs, but in the larger, median portion two or three. Mr. Muir found as many as 570 eggs in one uterus, and then the ovarian tubes are still full of eggs in various stages of development. As the eggs pass along the uterus to the exit they continue to develop so that when the uterus is full and the first are ready for laying the embryo is fully developed, the young larva leaving the thin membranous shell before it leaves the uterus, the empty shell being passed immediately afterward; in certain cases Mr. Muir observed that the egg was laid and the larva hatched out immediately.

The female oviposits just within, or without, the holes made by the beetle larva in feeding, especially in the hole made by the beetle just before pupation. The way the fly larva enters the beetle larva was not observed, as when placed on the host in the open the parasite refused to perform. The parasitized beetle larva continues to feed and eventually forms its cocoon, after which its strength fails it and the parasite emerges and pupates in the cocoon. On a few occasions the host dies before it can form its cocoon and the puparia are found in the "runs"; on two occasions the writers have found that the host had pupated before being killed and so the parasite emerged from the pupa. When a cage was stocked with small or only half-grown beetle larvae and the flies kept in for a week, few or none of the hosts were parasitized, whereas if all the hosts were nearly full grown then the percentage of parasitism was high. The number of parasites to one host varies, the highest number found being fifteen, all of which developed into perfect flies; naturally there is a great variation in the size of the adults and, more especially, of the puparia. The average number of parasites to one host in over one thousand cocoons in Amboina, Ceram and Hawaii works out about three and one-half. The length of time from fertilization to oviposition was never actually observed as we could not get the flies to copulate in small jars and it was difficult to watch oviposition; from indirect evidence it would appear to be about three days. From oviposition to adult is about 35 days, the larva about 20 days, and the pupa 15 days.

Several methods were employed for transportation. In Amboina experiments were made with cold storage but it proved a failure. The journey from Amboina to Hongkong is via Macassar and the connections there uncertain, another thing which made cold storage impracticable. In carrying the parasites between Papua, Queensland, Fiji and Honolulu when it was necessary to take every precaution against failure, the parasitized hosts were taken undisturbed in sugar-cane, pupae being carried in damp frass from the borer runs. When once the parasite was established in Hawaii it was found more convenient to place the parasitized grubs in small vials with small pieces of cane; in this manner they have been successfully sent to Samoa, Fiji and Formosa.

To breed the parasites successfully it was found necessary to have large cages in the open air, with a few palm leaves or cane leaves on top to regulate the sunlight, for too much light or shade seemed to be inimical to them; they also like small plants growing round the cane stalks. The hosts were inserted in artificially made holes in the sugar-cane, one to each internode, the holes being stopped with frass from the runs of larvae; the beetle grubs were either gathered direct from the fields or bred in large tubs in which many sticks of soft cane were placed with many adult beetles.

In Queensland our cages were built on the ground and the ants built their nest at the base of the standing cane stalks, but in spite of this we succeeded in breeding quite freely. Before leaving Mossman it was found that a few escapes had established themselves in cane near the cages and were breeding quite freely; if this cane had been cared for after Mr. Kershaw left there is no doubt that the fly would have become permanently established in the district.

The small cage used by Mr. Muir in Fiji was not a great success, but the large one built for him by the Colonial Sugar Refining Company and left by him ready for Mr. Kershaw's use, was quite a success. When Mr. Kershaw left Fiji he left behind enough flies for a new colony and one more generation was raised there, after which the colony was lost without the parasite establishing itself. In April, 1912, Mr. D. S. North took back to Fiji a good colony but they were not successful in establishing the parasite there. In August, 1912, and February, 1913, colonies were sent to the Vancouver-Fiji Sugar Company, but they also failed to get them established.

The reasons given for the faiures to establish the fly in Fiji were various, climate and the presence of enemies, such as ants, ear-wigs, lizards, spiders and birds being among them. The fact that the fly bred freely in cages in the open in Fiji showed that climatic conditions could not be the governing factor and the natural home of the insect is wetter than Fiji. As animal life of all kinds is more numerous in Queensland, Papua and the Moluccas than in Fiji the reasons given do not appear to be adequate.

Knowing of the good work the parasite was performing in the Hawaiian Islands the Colonial Sugar Refining Company of Australia was anxious to establish it in Fiji and Queensland. For this reason they wrote to Dr. H. L. Lyon in 1913 enquiring if he knew of any local entomologist who could undertake the task. The Station Entomologists not being available Dr. Lyon approached Prof. J. F. Illingworth of the College of Hawaii, who entered into an agreement to undertake the work. Knowing nothing of the life-history of the parasite, or of the methods we had used to handle it, he applied to our Station for information and Mr. Swezey gave him all assistance possible, showing him the manner of transporting, breeding and distributing the fly which had succeeded in Hawaii; he also took him to plantations where material could be most easily collected and helped him to collect it. With this help Prof. Illingworth succeeded in taking a large colony to Fiji and breeding and distributing large numbers. The former unsuccessful experiments having been made on the southern side of the island these latter were made on the northern side. By this means the parasite was finally established in the island, and colonies have been sent from there to Queensland.[6] We have had no official report as to the effect of the parasite upon the sugar industry in Fiji. A colony of *C. sphenophori* was forwarded by this Station to Samoa in 1913 at the request of the Samoan Government.

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[6] H. Tryon, Australian Sugar Journal VI. 3, p. 200, 1914.

HABITS AND LIFE HISTORY OF THE SUGAR CANE WEEVIL BORER IN HAWAII.

FOOD PLANTS AND FEEDING HABITS.

In the Hawaiian Islands the main food plant of *Rhabdocnemis obscura* is sugar cane, which gives the reason for its being commonly known as the Sugar Cane Borer. Other plants that are known to have been attacked by this insect are palms, bananas, papaia and maize, though it is only occasionally that any of these suffer injury. In regard to this Mr. Koebele writes:

[7] "Not only sugar cane is damaged by this insect, but many other plants are damaged by it, chiefly the bananas and coconuts. A grove of the latter was shown me in Hilo, in 1894, that was badly infested by the beetles. Setting fire to the dry leaves was recommended; this was done and the plants have since entirely recovered. Dying coconut palms were examined and in the tender heart of the palm was found great numbers of the insects, in all stages.

[8] "Many species of palms are affected and even destroyed, such as the *coconut*, the *royal* and *cabbage palms*, the two native species of *Pritchardia* have been seen destroyed by same, and several others. The *banana plant* is often seriously affected, not so much on these islands as in Fiji.[9] The *papaia plant* must be included, at least, in a decomposing condition, in which state it appears to live upon many plants. We have seen a trunk of the common *Caryota urens* (wine palm), cut up in lengths of about three feet and used as flower stands in a garden, completely riddled with holes made by the beetle, and they were still present within two years or more after the tree had been cut. Any tender or decomposing part of *palms* seems to answer them as food.

"Brother Newell of Hilo writes me lately that large numbers of cane-borer beetles were attracted upon shafts of leaves of the *royal* palm a few days after falling from the trees, and they would continue to come for weeks after."

Since the time of Mr. Koebele's observations, attacks upon other plants than sugar-cane have been noticed much less frequently, and now with the scarcity of the pest even in sugar plantations it is very seldom that a banana plant or a palm is seen infested by this borer. Sometimes the adult beetles are found behind the leaf-sheaths of palms doing no particular harm, and the tree itself not infested by them, the position apparently being only a temporary hiding place.

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[7] The Planters' Monthly, Vol. XV, p. 590, 1896.

[8] The Planters' Monthly, Vol. XIX, p. 519, 1900.

[9] The beetle that does the greatest harm to bananas in Fiji at the present time is *Cosmopolites sordidus* (Germ.), an insect often mistaken for ***Rhabdocnemis obscura***; the latter does little or nor harm now to bananas.

The instance of maize being attacked by the cane-borer was in July, 1909. A box of ripe ears of corn was received at the Experiment Station, having been sent in by the Maui Agricultural Company, of Paia, Maui. These were infested by borer larvae which had evidently passed from the corn stalks into the stem of the ear and thence to the cob, probably before the ear was ripe. Some of the ears showed where the larvae had also eaten amongst the kernels of corn close to the cob, and apparently as though this had been done while the kernels were yet immature. The corn was from a field growing in a district where the sugar cane was badly infested with the borer.

In sugar cane, the damage is done by the larvae tunnelling up and down within the stalk. Besides destroying the inner substance of the stalk at the place of eating, a fermentation of the juice of the cane follows, which may extend to some distance farther up the cane, thus rendering a great deal more of the cane worthless than merely what is eaten. The infestation may begin at the base of cane stalks about the time when the cane has one to three feet growth of stalk, and continue throughout the growth of the cane or till that particular stalk is dead, or broken off due to the weakening of the base by the eating of the borer. One borer larva may be sufficient to destroy the stalk, if it should happen to result in its breaking off; but often a cane may have one or more larvae in it at base and yet survive and grow without a great deal of damage resulting. This is noticeably true with respect to the Yellow Caledonia variety. Sometimes a cane may support as many as fifty or more larvae, when, of course, it is completely destroyed and rendered entirely worthless. There are all degrees of injury between these extremes, and from one to all of the stalks in a stool of cane may be infested, according to the abundance of the pest and the severity of the infestation.

The adult beetles are nocturnal and of secretive habits, so that they could be very abundant and yet never be seen unless sought for in the proper places. A favorite hiding place is behind the leaf-sheaths of the cane, especially those which have commenced to loosen from the stalk. Here they feed upon the inner part of the sheath, eating out furrows between the longitudinal fibers. They are unable to eat their way into the cane itself, but in broken canes or those that have been gnawed by rats, often many beetles are found where they have burrowed into the cane by feeding on the juicy pith between the fibers. It is also probable that where the larvae have been numerous in a cane and it is much eaten, the beetles that mature therein may stay inside for a considerable length of time and go on with egg-laying without migrating to other canes.

Although flying of the beetles takes place chiefly at night, Mr. Koebele has written as follows on their day-flying:

[10] "Often the *Sphenophorus* beetle has been seen flying during the hottest part of the day, around mills in operation on these Islands; most numerously they were observed on Kauai at sunset until dusk, coming from a recently burned field across the road and settling down upon the young plants. Its wings are well developed and its flight is very rapid, so much so as to be with difficulty followed with the eyes."

OVIPOSITION.

[11] "The female having entered beneath a leaf sheath which has commenced to loosen from the stem usually selects for oviposition that internodal area above the eye, the sheath acting as a fulcrum for her body, thus facilitating the preparation of a cavity for the egg, the sharp-toothed mandibles (Pl. I, figs. 12-13) coming into requisition for this act. Having pierced through the cane-rind, a short curved passage following the curve of the rostrum, is made into the tissue beneath, to a depth of about 1/8 inch. The beetle then completely reverses her position, brings the extremity of the abdomen to the egg-cavity, and places a single egg therein by the aid of the ovipositor, this egg always being placed with its long axis parallel to the cane fibre. The time occupied in ovipositing is evidently very variable, since Mr. Koebele says: '4 to 6 minutes,' whilst from my own observation it is much less, on one occasion being only 1/2 minute.

"This act may be repeated within a relatively small area of the internode, but usually two or three egg insertions are the maximum for one internode."

Eggs are occasionally inserted into the leaf-sheath also, and the mid-rib of the leaf. Where broken or rat-eaten cane is available many eggs are laid directly in the juicy pith, it being much more easily accomplished than where the rind has to be penetrated in the usual way. This is one reason why rat-eaten cane is so much more infested by borers than the sound cane.

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[10] The Planters' Monthly, Vol. XIX, p. 519, 1900.

[11] F. W. Terry, Circular No. 3, Div. Ent., Experiment Station, H. S. P. A., p. 12, 1907.

THE EGG. (Pl. I, figs. 1-2.)

[12] "The egg is ivory-white and enclosed in a thin tough membrane, narrowly oval and slightly curved, varying somewhat in form and dimensions, e. g., from 1.35 x .55 mm. to 1.75 x .6 mm. (averaging about 1/17 x 1/45 inch. Pl. I, fig. 2c)."

THE LARVA. (Pl. I, figs. 3-6, and Pl. II, figs. 2-3.)

[12] "The incubation period is usually constant, the larva hatching about the sixth day; the egg membrane splits longitudinally and the young larva upon emergence is of a pale translucent ivory whiteness, with the exception of the slightly darker mandibles. At this stage the larva is not larger than the egg, usually about 1.40 x .5 mm. (1/18 x 1/50 inch). The chitin of the head and mandibles soon darkens and hardens, becoming after a few hours yellow, and later on reddish-orange as the larva approaches full growth.

"The full-grown larva (Pl. I, figs. 4-6), including the head, averages 15 mm. x 8 mm. (about 3/5 x 1/3 inch), and is a footless, deeply-wrinkled, swollen-looking grub, pale yellowish-grey, the food material often showing through the translucent skin of the distended abdomen. Just behind the head, the chitinous layer of the upper part of the first segment is thickened, forming a yellowish narrow plate, the *cervical shield* (Pl. I, fig. 5b). The head is oval and bright reddish-orange, and the simple eyes are so extremely minute that they are difficult to see, and must be practically functionless; both head and body are sparsely covered with stiff hairs, which no doubt serve as tactile organs whilst the insect travels through its tunnels. The blackish mandibles are very strongly chitinized and well adapted for chewing the fibrous stem-tissue (Pl. II, figs. 2-3). As in other insects (larval and adult), the respiration is carried on by means of tracheae; these tubes are very numerous and ramify (like the roots of a plant) throughout the entire body, becoming extremely fine at their extremities; this tracheal system communicates with the external air, through a series of slit-like openings or spiracles; these spiracles (Pl. I, fig. 5a) are arranged in pairs, usually one pair to each body segment.

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[12] F. W. Terry, Circular No. 3, Div. Ent., Experiment Station, H. S. P. A., p. 9, 1907.

"The larva very shortly after hatching proceeds to work its way into the stem tissue, frequently taking a downward course, but usually it continues in an upward direction, frequently traversing and enlarging its old course with its increasing appetite and bulk. The diagrams (Pl. II, figs. 5-9) illustrate the feeding methods from actual experiments. Newly-hatched larvae were inserted in isolated growing cane; the adult beetle emerging at *b; c* representing the cocoon (the arrow indicates the course taken by the larva). From my breeding notes I find one larva remained below the point of insertion during its entire feeding period, finally emerging opposite the insertion hole.

"Although large quantities of stem tissue are digested and excreted as frass, immense quantities are simply masticated to express the juice, both forms of waste material serving to block up the larval passage (Pl. II, fig. 4f). As an illustration of the voracity of the larva, Mr. Koebele says: [13] 'A half-grown specimen traversed a piece of cane six inches in length, from one end to the other, in three days.'

"Frequently the larva approaches too closely to the rind, breaking through and producing rupture holes (Pl. II, fig. 4b) of various sizes; these when very small are frequently mistaken for egg-insertion holes (Pl. II, fig. 4c), or, when larger, exit holes (Pl. II, fig. 4a).

"The larval period varies greatly, as the previous experiments of Mr. Koebele and recently my own prove. Mr. Koebele says: [13] 'It is difficult to ascertain the number of moults the larva goes through; as far as can be made out it is six, becoming full grown in about seven weeks, more or less, according to condition of food plant.'

"My own experiments during August-November, 1906, gave an average of 81 days. This variation is largely dependent upon the condition of the cane and also temperature, a soft cane and high thermal average naturally inducing more rapid development. The attempts of both Mr. Koebele and myself have failed to determine definitely the number of larval moults, the feeding habits making this practically impossible.

THE PUPA. (Pl. I, fig. 7.)

[14] "The full-grown larva, preparatory to pupation, eats out an exit hole in the rind and constructs (usually just above it) a strongly-made cocoon composed of cane fibers, wound spirally and kneaded compactly together (Pl. I, fig. 8, and Pl. II, fig.

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[13] The Planters' Monthly, Vol. XIX, p. 520, 1900.

4d). Within this cocoon the metamorphosis takes place. This metamorphosis is so complete that not a single organ, internal or external, remains the same; all the external organs of the future beetle are clearly defined (in the pupa), although *ensheathed* in a translucent covering of chitin.

"The newly-formed pupa (usually head downward in the cocoon) is of a pale creamy white, but gradually the markings of the future beetle develop; at first these are pale brown, but rapidly darken. The future elytra are at this stage quite soft and folded around the sides of the pupa (Pl. I, fig. 7c); the sheaths containing the wings can be seen projecting just beyond these (Pl. I, fig. 7d). The pupal period is somewhat variable. Mr. Koebele says: 'The transformation of the pupa takes two weeks, and another couple of weeks will elapse before the insect issues.' My own experiments during August, 1906, gave a range of 8-9 days for the pupal period, and 4-7 days before the beetle had attained its normal coloration and hardness."

THE ADULT. (Pl. I, figs. 9-13, and Pl. II, figs. 1-1f.)

[14] "So familiar an object is the adult beetle on the plantation, that a detailed description is unnecessary. The general coloring is a dull light brown, the prothorax being usually brighter, with a blackish central band. The elytra are darker, with one pair of blackish patches and one lateral; the whole often covered with a greyish pubesence. Fine but distinct impressed lines run longitudinally along each elytron. The very conspicuous curved rostrum readily distinguishes the borer from any beetle occurring in the cane fields. The difference of form in this organ also serves to easily identify the sexes, that of the male being much thicker and less curved, the under surface having a double row of tubercles (Pl. I, fig. 11); the finer and smoother structure of the female rostrum (Pl. I, fig. 10) being better adapted for preparing the egg cavity. Plate I, fig. 12, shows the apex of the rostrum with the partly-opened sharp-toothed mandibles; these teeth dove-tail neatly together when closed. A view of the rostrum from beneath, with the mandibles widely distended, is shown on Plate I, fig. 13.

"The maxillary palpi (Pl. I, figs. 12-13b) function as guiding organs for the food material and assist in mastication. One other sexual difference readily distinguished is the blunter form of the male pygidium (Pl. II, fig. 1f) when compared with that

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[14] F. W. Terry, Circular No. 3, Div. Ent., Experiment Station, H. S. P. A., p. 11, 1907.

of the female (Pl. II, fig. 1e). A portion of this segment is covered by the elytra (Pl. II, fig. 1c).

"An adult female (Pl. II, fig. 1) is shown with the right wing extended for flight; each wing is strengthened by thickened chitinous veins, and when not in use is folded up at its middle (Pl. II, fig. 1b) and lies over the back, protected by the elytron (Pl. II, fig. 1a). Each leg is furnished with a strong curved spine at the extremity of the tibia, enabling the insect to grip very securely and resist any ordinary attempts to dislodge it, as well as to dig into the cane tissue. The foot is segmented and bears, in addition to a pair of strong claws, a large pad, the third tarsal segment (Pl. II, fig. 1d), the under surface of which is densely clothed with adhesive hairs by which means the beetle can walk with perfect facility up the smoothest surface."

SUMMARY OF LIFE CYCLE.

	(Per Koebele)	(Per Terry)
Preparation of the egg cavity:	1½-2 minutes.	One female observed eating out hole occupied less than 1 minute.
Oviposition:	4-6 minutes, much longer in hard rind.	½ minute in ordinary Lahaina cane.
Incubation period:	6 days, from repeated observations.	5-7 days; average 6 days from repeated observations.
Larval period:	About 7 weeks according to condition of food.	76-91 days; average about 81 days.
Pupal period:	2 weeks.	8-10 days; average about 9 days.
Adult remains in cocoon before emerging:	2 weeks.	About 10 days.
Period from egg to adult.	About 3 months.	95-104 days; average about 99 days.
Duration of life of adult female borer.	"Probably 10-12 months, half of which period she deposits eggs, probably 4-8 per diem."	

DAMAGE TO CANE.

As has been so commonly observed, the softer varieties of cane are more abundantly attacked by the borer, and suffer the greatest amount of injury. Of the two leading standard varieties grown in Hawaii, the Lahaina, a soft cane, suffers much greater loss by the borer than the Yellow Caledonia, which has a much harder rind and nodes which the borer larvae have greater difficulty penetrating in boring up or down the stem. Even though eggs are laid in canes with a harder rind, many of the larvae perish when very young, not being able to feed satisfactorily in the hard fibrous tissue.

Many of the valuable seedling varieties produced at the Experiment Station the past few years proved attractive to the borer, and when planted in trial plots on certain of the plantations where borers were abundant (and even in some places where borers were ordinarily rather scarce) were practically ruined by the borers migrating from the surrounding fields and segregating on some of the specially soft varieties. Attempts to grow certain of these new varieties were abandoned on some of the plantations on account of this. The fact that certain of the Hawaii seedlings were so badly attacked in the experimental plots on some of the plantations, led to the idea that these seedlings as a class were subject to borer attack and in several cases plantations temporarily abandoned further trials of any of the seedlings. Accurate observations, however, showed that certain of the Hawaii seedlings were remarkably free from borer attack, even when growing between other seedlings that were badly injured. This was well shown in some plats at the Experiment Station which were harvested in February, 1913. These plats were for tests of certain of the Hawaii varieties in comparison with standard varieties in respect to yield of cane and sugar per acre. Before harvesting the plats had the appearance of being considerably infested by borers. It was found, however, that the serious infestation was confined to but a few varieties, rows of which were growing between the rows of the other varieties in the plats. Those badly infested were H 25, H 27 and H 70; those moderately infested were Lahaina, H 227, H 269, and H 369; those slightly infested were Striped Mexican, D 1135, H 33, H 69, H 240, H 276, and H 291; those with only a trace of infestation were Yellow Caledonia, H 90, H 133, H 138, H 146, H 168, H 197, H 199, H 280, H 344, and H 376; while Caledonia Ribbon, H 147, H 167, and H 379 were not at all infested. It will be seen that by far the greater number of the Hawaii varieties in these tests were nearly free from borer attack. A few other varieties which have been shown to be very susceptible to borer attack on the plantations are: H 16, H 24, H 69, H 106, H 109 and H 309.

Not all of the Hawaii seedlings have been compared in regard to borer attack. The above shows that there is great difference in their susceptibility and points out those of special significance, the planting of which should not be recommended where borers are very prevalent; but there are plenty of others available to choose for use in such circumstances. For convenience the varieties above mentioned are arranged in tabular form below. These comparisons might not be the same under all circumstances.

TABLE SHOWING COMPARATIVE INFESTATION BY BORERS OF CERTAIN VARIETIES OF CANE.

Bad Infestation	Moderate Infestation	Slight Infestation	Trace	None
Lahaina	H 227	Striped Mexican	Yellow Caledonia	Caledonia Ribbon
H 16	H 269	D 1135	H 90	H 147
H 24	H 369	H 33	H 133	H 167
H 25		H 69	H 138	H 379
H 27		H 240	H 146	
H 69		H 276	H 168	
H 70		H 291	H 197	
H 106			H 199	
H 109			H 280	
H 309			H 344	
			H 376	

It is also the case that fields in which the cane grows ranker in spots will have greater infestation in these rankly growing spots. Lowlying fields and those in valleys are likewise more infested by borers, and, other things being equal, those plantations in the very drier districts are less infested than those having a rainier climate, though it is not necesarily the very wettest districts that are the most infested by borers. In general, the windward sides of the islands are the more rainy, and the plantations of the windward districts suffer from borer attack much more than those on the leeward or dry sides of the islands.

In some of the plantations most severely infested, often there would be a loss of half the crop in certain fields, and even greater percentage of loss sometimes in spots, the greatest loss often being in conjunction with the work of rats. Often in gulches, or where the cane is rank and has fallen down badly, or where near to stone piles or walls which harbor rats, a great deal of cane is eaten by the latter. The borers are attracted to these places and gain easy access to the canes where injured by the rats, and it often results in the destruction of the rest of the cane left by the rats.

In some circumstances a plantation may be so situated that one end is in a region favorable to the borers and has consequently suffered severely from them, while other parts of the plantation have been quite free from loss by borers. In not many cases have the plantations suffered severely from borers throughout, though a few have at times done so. Often the maximum amount of damage is done in those fields which of necessity have to stand for a long time after maturity, before being harvested. The prolonged harvesting season prevailing in the Islands requires that some fields have to wait several months before their turn to be harvested.

It is impossible to give an accurate estimate of the total annual loss to the sugar industry by this pest. The proportion of destroyed canes could be taken as an estimation of percentage of loss; but this is not the only loss, for many canes partially destroyed and having fermented juice go into the mills along with the sound cane, resulting in impairment of the juice of the latter. Since the infestation has been so irregular throughout the plantations, ranging from 0 to 50%, or even more, it is impossible to strike any average per cent of infestation; but from an average crop of about five tons of sugar per acre, supposing an average of 5% has been lost by borer, with sugar at $75.00 per ton, this would equal $18.75 loss per acre. This would give a total of $1,875,000 for the annual harvest of about 100,000 acres. Perhaps 5% loss is a little too high an average. Figured at 2%, which would certainly be low enough, a total annual loss would be $750,000. It would seem, therefore, to be very conservative to consider the annual loss at about one million dollars.

A few plantations have suffered proportionately much greater than others, even to about one-fourth of their entire crop and amounting to $50,000 to $150,000 annually for the plantation.

ARTIFICIAL MEANS OF CONTROL.

BURNING OF TRASH.

The common practice of burning off the trash, i. e., dried leaves and dead canes, as soon as the cane has been harvested, destroys immense numbers of the borers and accomplishes more in checking the pest than any other method employed. It kills the grubs in the canes, and any beetles that may be hiding in the canes or amongst the trash. Nearly all perish in this burning, but a few larvae that have followed the canes down below the surface of the ground will survive in the stools and be ready to infest the next ratoon crop. On plantations badly attacked by borers, where burning of trash had not previously been practiced, it was found that there was a considerable reduction in loss by borers when the burning of trash was adopted. Burning of trash has been practiced for other reasons, but its effects in borer reduction is an important one.

The plantations of the specially dry districts have of recent years followed the practice of running a fire through the field before the cane is harvested, for the purpose of burning the trash so as to facilitate harvesting. This is even more effective in checking the borer and has resulted in still further reducing the loss by borer in those plantations where this practice is employed. Nearly all of the adult borers will be caught by the fires; whereas, if the trash is not burned till after the cane is harvested, many of the beetles present will have an opportunity to fly away to other fields before the burning takes place.

STRIPPING.

Many plantation managers have been of the opinion that the practice of "stripping" lessens the loss by borer attack, and it probably does, but is of much less importance than the preceding. The removal of the dead and dying leaves from the cane stalks makes it less favorable for the borers, as the beetles habitually crawl down behind the loosened leaf-sheaths of old leaves to oviposit, and can not oviposit on the bare stalk. Then, too, with the leaves stripped from the canes there is more free access of light and air, conditions not attractive to the beetles, which would go elsewhere where conditions might be more to their liking.

BAITING.

The fact that beetles are attracted to injured canes may be made use of to trap them by means of split pieces of cane being laid in heaps at convenient places along edges of fields and along irrigation ditches. These should be visited daily to destroy the beetles that have come to feed upon the juice of the cane. This method has been utilized on some of the plantations with beneficial results. Even though collections of the attracted beetles were not made, some good would be done by this baiting, for many eggs would be laid in the pieces of cane. The larvae hatching from these eggs would mostly perish, as the cane would become too much dried up or decayed before they could reach maturity.

Much more use has been made of this method of control in Fiji than in the Hawaiian Islands. In the latter much more dependence has been given to the burning of trash, or firing the cane.

HAND-PICKING OF BEETLES IN THE FIELD.

Several of the most badly infested plantations have carried on this method continually for a number of years, being done mostly by women and children going through the infested fields and searching for the beetles, chiefly behind the leaf sheaths of the cane. Objections to the method are the occasional breaking of a cane, and the tearing off of leaves that should still be serviceable to the cane. Experienced collectors, however, soon learn that the beetles are more readily found beneath the sheaths of the older leaves already dying and partially loosened from the stalk; and care can be exercised in regard to the breaking of the canes in going through the fields. But even these injuries are offset by the benefit derived from the capture of the beetles.

Payment for this work has been on a different basis on different plantations, or at different times. When paid by the day, the rate has ranged from 25 cents to 50 cents per day, according to age and aptitude of collectors. When paid for the amount collected the rate has ranged from five cents per hundred to twenty-five cents per ounce. There is an average of about 300 beetles per ounce. The highest record of amount collected on one plantation during a single year was 26,417.25 ounces, which would be equivalent to 7,925,175 beetles—85/100 of a ton. The destruction of this enormous number of beetles would make a great difference to the later infestation of the plantation.

SELECTION OF VARIETIES OF CANE.

As previously mentioned, the borers have a preference for some varieties when there is opportunity for them to make a choice; also, some varieties, though infested, do not suffer so severely from the attack as others. The Yellow Caledonia is notably one of the latter, and it has been of advantage to plant this variety in those fields which were favorite localities for borers. A crop of it could be grown at times when a softer variety might have been almost a total loss. On the other hand, it would not be advisable to plant such varieties as H 16, H 24, H 25, H 27, H 69, H 70, H 106, H 109 and H 309 where there is likelihood of borer attack, as these varieties have proved very susceptible to destruction by the borer.

SELECTION OF SEED CANE.

Naturally, in planting new fields care should be exercised that the "seed" is not already infested with borer larvae or eggs.

If larvae were present they would eat so much of the "seed" as to make it worthless for the support of the new shoots of cane while first getting started, and probably result in their dying later on, and thus causing an uneven stand in the field, or necessitating replanting. This plating of infested "seed" is one way in which borers have become established in regions where they did not previously exist. Undoubtedly the borers were first brought to the Islands in importations of "seed" cane, some of which contained the eggs or small larvae of the borer. Where the "seed" is taken from non-infested fields there is no danger and no precautions are necessary; but where "seed" is taken from infested fields careful examination should be made that no infested cuttings are taken.

NATURAL ENEMIES IN HAWAII.

The cane borer is very little disturbed by natural enemies in the cane fields of the Hawaiian Islands. Being an introduced insect and in a place where there are no special enemies to insects of its kind, there have been no natural enemies of any consequence preying upon it. A few of minor importance have been noted.

Monocrepidius exul. The larva of this Elaterid beetle is predaceous. It occurs under stones, in soil, and has been found in rotten borer-infested cane lying on the ground. It no doubt feeds on any kind of insect or insect larvae that it finds. It has been found in cocoons of the cane borer, having forced its way through the fibers and eaten the borer pupa inside. The beetle and larva are figured in *The Hawaiian Planters' Record,* Vol. III, p. 8, 1910, where some account of it is given by F. W. Terry.

Ants. Several species of ants are always abundant in canefields. Borer-eaten canes provide them with a favorite nesting place, where they clean out the channels for this purpose. Usually the borer grubs are sufficiently enclosed by the frass behind them in the channels to protect them from the ants, but not all escape. Probably some pupae are eaten also, though the dense fibrous cocoon usually sufficiently protects them.

Acarid. An Acarid is often to be found on the adult beetles. It is not likely that it kills them, but the pupae are sometimes killed. This Acarid became very abundant in the insectary in the cages or other receptacles in which borer larvae were being reared for use in breeding Tachinids. Sometimes the beetles would be nearly completely covered by them. Three hundred fifty-two were counted on one beetle. They probably are not very harmful, but no doubt act as an annoyance.

Rats. Quite a good many borer pupae are eaten by the rats. They gnaw into the cane at the place where a cocoon is situated just inside the rind. Apparently by the sense of smell they know where the cocoon is located and gnaw through to secure the pupa, larva, or beetle, whichever the cocoon contains. In fields where rats abound, these places where they have gnawed out the borer cocoons are often to be seen in large numbers. Sometimes in "scouting" for Tachinids it was found that nearly all of the cocoons had been eaten out by rats, and it is very likely that to some extent they have eaten puparia of the Tachinid, and thus delayed the latter in becoming generally spread.

Mongoose. This much maligned anmial is chiefly a feeder on insects. An examination of their fæces as found in plantation fields, shows that they feed largely on insects such as roaches, crickets, mole-crickets, grasshoppers, earwigs, ants, Japanese beetles, and adult cane borers. Often in the fæces examined the hard parts such as legs and wing-cases of these insects have made up as high as 80 per cent.

Toads. Several species of these were introduced from California and Japan about twenty years ago by Mr. Koebele, in the hope that they might become established in cane fields and feed on cane borers as well as other insects. Of these, one very large one is occasionally seen in cane fields, but it is too rare to be of much service even if it fed to any extent on borers. It would most likely feed chiefly on the other insects found among the trash.

Birds. The Mynah bird, which frequents the plantation in flocks, no doubt picks up an occasional borer beetle, though it is more likely to get spiders, cutworms, crickets and other insects.

Parasitic Fungus. A fungus disease called the "green muscardine," caused by *Metarrhizium anisopliae,* kills a great many of the grubs and adults of the Japanese rose beetle, especially in wet sections of Hawaii and in rainy seasons in the dry districts. This fungus also attacks the cane borer to some extent, but not nearly so much as it does the Japanese rose beetle. In examining borer-eaten cane in the fields one only occasionally finds dead borers that have been killed by the fungus. However, if collected beetles are confined in breeding cages, many of them develop the disease and succumb to it, indicating that they were already infected in the field. The conditions in the breeding cages being more favorable for the development of the disease, many more of the beetles died from it than probably would have if they had been left in the field. On pages 46-53 of Bulletin No. 12 of the Pathological and Physiological Series, Mr. Speare gives an account of this fungus and some experiments in artificially inoculating borer beetles by it. Some of these experiments resulted in a mortality as high as 40 per cent.

Altogether these natural enemies account for only a small proportion of the pest, but it all helps a little.

BREEDING AND DISTRIBUTION OF THE NEW GUINEA TACHINIDS IN HAWAII.

On Mr. Muir's arrival with the Tachinids, a certain number of the adult flies were liberated directly in borer-infested cane-fields. Other flies as they emerged from the puparia brought were retained for breeding. Several methods were tried at first. It was found that cages inside the insectary were not successful, while cages built over standing cane in the fields were very successful; but as there were so many ants in the soil and it was thought that they would interfere too much, cages were finally built like the one in Fig. 1.

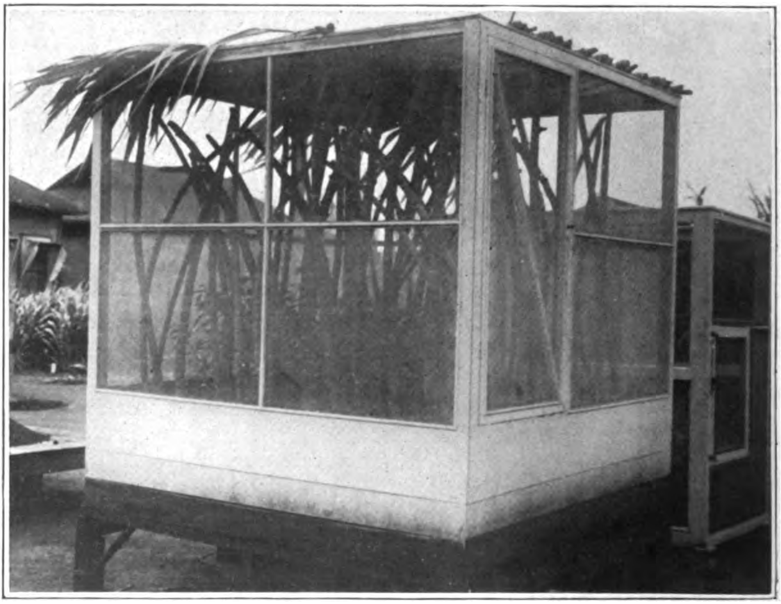

Fig. 1. Breeding Cage for Tachinids at Experiment Station.

CONSTRUCTION OF BREEDING CAGE.

This cage was seven feet square and seven feet high, standing on posts one foot high. The posts have a strip of cloth wrapped around them on which to place ant repellant. This did not prove satisfactory, and so a small granite-ware pan was placed under each post to be kept filled with water, and thus trouble from ants was avoided. The cage has a foot of soil on the two-inch plank floor and the board sides extend a foot above the surface of the soil. The remainder of the sides is covered with mosquito netting. The top is wire screen. A few cane tops and palm leaves were put on top for partial shade. The door is of sufficient size to allow one to enter readily and for carrying canes in or out.

PREPARING THE CANES, AND CARE OF CAGE.

The canes shown standing in the cage were prepared by boring a hole in each internode of sufficient size so that a nearly full-grown borer grub could be inserted, the hole then being plugged with the frass from the channels of the borers in infested cane. In this way twelve to twenty borer grubs were placed in each cane. The canes were then stood up in the soil in rows, and as many as could be arranged conveniently. Some of the canes took root and shoots started out from the buds; but usually they did not. However, they kept in good enough condition to serve for the nourishment of the grubs a sufficient length of time.

Small propagating boxes with young Eucalyptus trees were placed between the rows of canes to serve for growing vegetation and a shelter for the Tachinid flies.

When fully ready the flies were put in, about 50-75 in number. The cage was sprayed daily when it was not rainy weather.

In a few instances a number of naturally "borered" canes were used along with the other canes. These were more satisfactory than the others, as the Tachinids bred more abundantly from them. But naturally "borered" canes were not readily available, as the Experiment Station is situated in the city and several miles from any borer-infested cane fields. The borers for inserting in the canes of the cages were often obtained by going to the plantations where harvesting was going on, or into badly infested fields, cutting up the infested canes and collecting all of the nearly full-grown grubs. Along with this the breeding of borers was carried on in the insectary. A quantity of some soft variety of cane was cut up into the proper lengths to stand up in large galvanized iron garbage cans. When filled, a large number of adult beetles (obtained from a plantation where they were being regularly collected from the fields) were admitted to these cans. Oviposition took place in the canes, and in the course of 6-10 weeks there would be many grubs that could be used in the breeding cages. Sometimes pieces of these canes were put into the cages, but usually they were so much decayed or eaten up by the borer grubs that it seemed best to transfer the grubs to fresh canes for the cages.

When the supply of grubs from this source was not sufficient to supply the cages, trips would be made to the plantations to collect grubs, as above-mentioned.

Several cages were used, so there was a continued succession either being prepared, or the contents being removed to send to the plantations. Some smaller cages covered with wire screen were used sometimes, but did not prove so satişfactory as large cages as above described. The adult Tachinids when put into the wire screen cages injured their wings flying against the screen, and did not live so long as in the mosquito net cages. Not so large a proportion of the grubs became parasitized that were put into canes in the wire screen cages.

BREEDING CAGES ON THE PLANTATIONS.

It was planned to start breeding cages on the various plantations to more quickly secure the establishment and general distribution of the Tachinid. Accordingly, on six different plantations to begin with, cages were prepared under the supervision of some member of the entomological staff of the Station. It was not possible for the entomologists to give personal attention to these more than to see that they were started right, and someone on the plantation instructed as to daily care, etc. Some of them were visited when the first generation was about due, to assist about the liberation in the field and further preparations for continunig the breeding. In only one instance was there success with these cages. On only one plantation[15] were they able to keep the breeding going on for several generations till the Tachinids were established throughout the plantation. In one other case the first generation bred successfully in the plantation breeding cage, and furnished a good colony for liberation in the field, which resulted in the establishment of the Tachinid there and its ultimate spread throughout the plantation. But attempts to breed additional generations in the cage failed.

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[15] Kilauea Sugar Plantation Co.

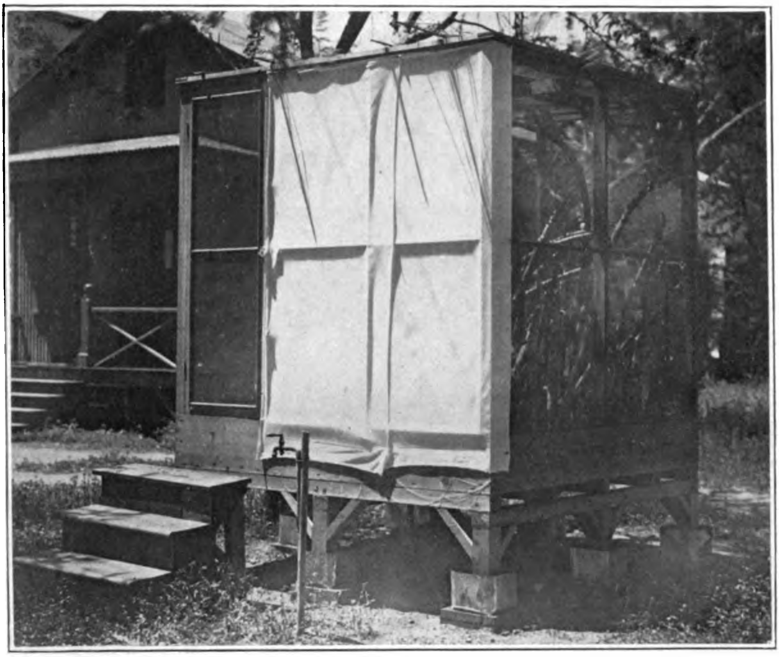

Fig. 2. Breeding Cage for Tachinids at Ewa Plantation.

BREEDING AT THE EXPERIMENT STATION.

Being disappointed in this plan, efforts were concentrated on the breeding cages at the Experiment Station, and as rapidly as they could be bred, colonies were sent out to a certain few of the plantations which were suffering the most from the borer. Successive colonies were sent to these few plantations until by examination in the field it was found that the Tachinid was well established; then colonies were sent to other plantations until all had been supplied. This breeding and distribution was carried on for two years, being supplemented the second year by numerous colonies collected in the fields of one of the plantations where they had first become established and already abundant.

METHODS OF DISTRIBUTING COLONIES OF TACHINIDS.

Adult Flies. In several instances the adult flies were taken by one of the entomologists personally, either in a small cage or in a glass jar, and they were liberated directly in the field.

Canes containing Puparia of the Tachinid. The common method of shipping colonies to the plantations on the other islands was by removing the canes from the breeding cage after about five weeks, when the Tachinids were mostly in the puparia, packing these canes in boxes and shipping by freight to the desired plantation, with proper instructions for handling, etc. The canes were packed in the boxes with excelsior between, near the ends only, so that there was plenty of space to allow the flies when emerging to make their escape from among the canes, as the box was to be set up in the field with the cover removed and left for the flies to emerge when they were ready and go to the infested cane of the vicinity. Figure 3 shows a box arranged in the field.

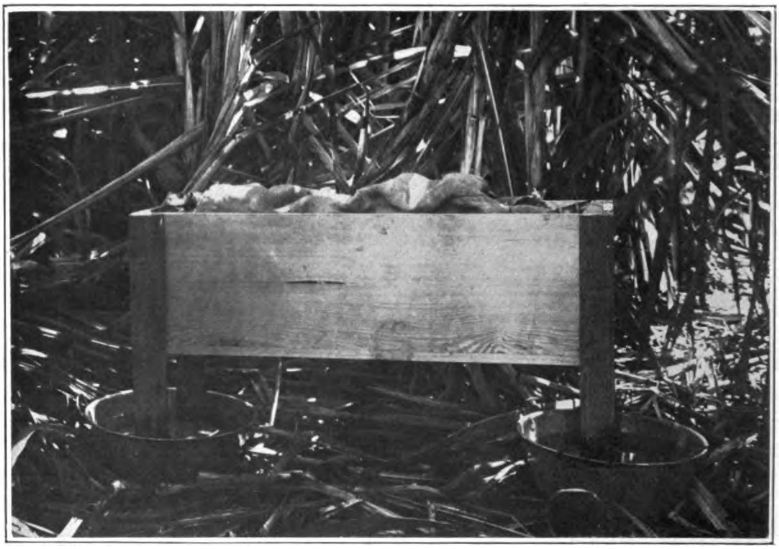

Fig. 3. Showing box of canes from cage, arranged in field for emergence of Tachinids.

Instructions were supplied for arranging to exclude ants, preparing shade, daily attention, etc., which was to be observed for at least three weeks. This method proved successful. About fifteen canes from the breeding cage were put in each box, being cut the proper length to fit the box, which was one foot wide by one foot deep and three feet eight inches long. Usually two of these boxes were sent to the same place at one time. Sometims but one was sent, and sometimes as many as four. In one instance where but one box had been sent, it was returned to the Station with all the canes in it after the flies had had ample time to emerge. A careful examination was made, and it was found that only 126 flies had emerged, as evidenced by their empty puparia within the borer cocoons in the canes. Yet this small colony proved sufficient for the estabishment of the Tachinid in that plantation, for on searching in the fields thirteen months later, they were found to have become established and spread to the distance of one mile. There were other cases in which the Tachinids became established from a single box of these canes sent to a plantation, but in none of them was any count made of the number of flies that emerged.

Puparia. Another method of distribution was by sending the puparia packed in damp moss. This method was specially used when, later on, colonies were collected from the fields of one plantation where they were already established, to be sent to other plantations where their establishment had not yet been accomplished. 100-250 puparia were sent out in each colony, according to the number available at the time of sending. The usual number per colony was about 150. Instructions were sent with them to arrange for liberation in the field similar to Fig. 4. The puparia are in damp moss in the glass jar which stands in a tin of water to keep out ants. The cardboard disc around the neck of the jar is to prevent the flies accidentally dropping into the water when they crawl up out of the jar before their wings have fully expanded. The whole is in a box for shelter from the weather and placed in a shady place in the cane field. It was to be looked after daily for two weeks till there had been time for all the flies to emerge.

An example of the success of this method is shown by one plantation where a colony of only 130 puparia was sent. When investigated eleven months later the Tachinids were found established and spread all over the plantation. This was not one of the larger plantations. For the larger ones several colonies were sent, not always at once, but at successive intervals according to convenience of obtaining them.

DETERMINATION OF ESTABLISHMENT AND SPREAD OF THE TACHINIDS.

The distribution of colonies of Tachinids began in September, 1910. In a year from that time fifteen of the plantations had been supplied with one or more colonies, some of them several colonies. In another year's time colonies had been supplied to the remaining plantations.

About five months after the first colonies of the Tachinids

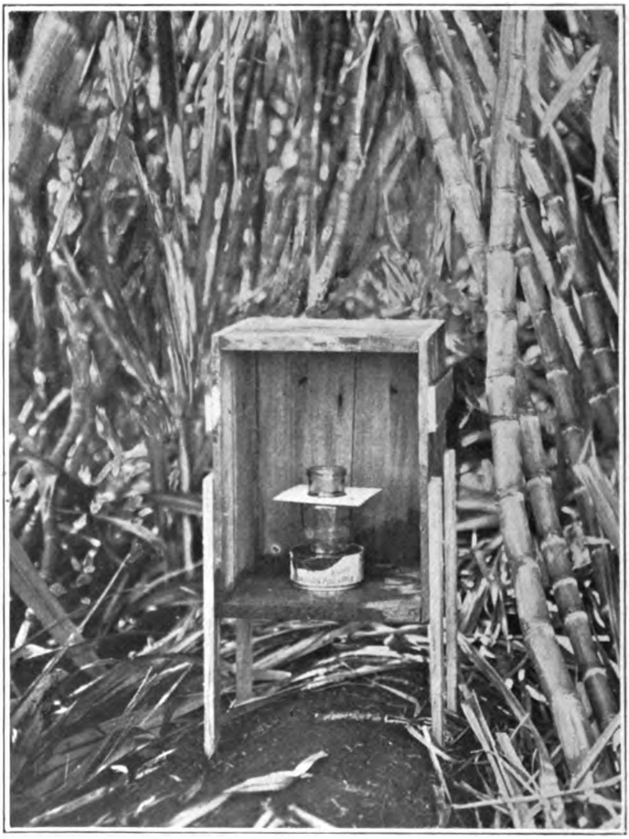

Fig. 4. Showing method of arranging jar with puparia in the field for emergence of the Tachinid flies.

were liberated in plantation fields investigations were made to ascertain whether they had become established. In four plantations thus visited, after considerable search near the localities where the parasites were liberated, a very few were found, in some cases but a single specimen. Another visit was made to each of these plantations four months later, or nine months from the first liberation of parasites, and they were very readily found, well established and spread from ½ to 1½ miles in the adjoining fields. This length of time had been sufficient for five or six broods, which accounts for their rapid spread after once becoming established. In one extensive plantation in a little over a year, they were found to have spread for three miles from the original colony, practically to all borer-infested fields—in fact, the flies were to be found in fields where it was very difficult to find any cane injured by the borers.

The determination of the establishment, or presence of the Tachinids in a field, may be by several methods. Often the flies themselves may be seen sitting on the cane leaves, or on the cane stalk searching for the proper place for oviposition. When once familiar with them they are very easily distinguished from all other flies occurring in the cane fields—or anywhere else in the Islands, for that matter. The most certain method, however, is by cutting into the canes infested by borers, and examining any borer cocoons found. If the parasites are present in the field these borer cocoons may contain the Tachinid puparia, either living ones, or the empty ones from which the flies have previously emerged; or, often the maggots of the Tachinid may be found to have just emerged from the dead borer larva and have not formed their puparia yet; or occasionally one may happen to open a cocoon and find the borer larva apparently alive but really full of the maggots which have not quite finished it yet. In searching for these cocoons one becomes adept at recognizing the holes in the cane made for the exit of the matured borer and knows just about where to cut into the cane to strike the cocoon, it being near this exit hole or a little above it. Aside from the above methods, any large borer larva found should be opened in search of the maggots of the Tachinid. Sometimes one may ascertain the presence of the Tachinid in one way and sometimes in another, so in "scouting," use is made of all these methods.

By the end of 1911, or fifteen months after distribution of colonies began, the Tachinids were found established in nine of the plantations, and in the most of these already quite widely spread. During 1912 scouting was conducted on other plantations when sufficient time had elapsed following the sending of colonies of Tachinids to these places, and on fourteen more they were found to have become established, making a total of twenty-three at the end of 1912. Similarly it was found during 1913 that they had become established on sixteen more plantations, or a total of thirty-nine at the end of 1913, being all but a very few of the plantations included in the Hawaiian Sugar Planters' Association. They became established as well in the few smaller plantations not belonging to the Association, although these had not been supplied with colonies. The Tachinids spread to these, however, from adjoining plantations where they had become established.

BENEFITS DERIVED.

The Tachinids had become so well established and sufficiently abundant that in 1913 there was a noticeable reduction in the number of borers in the fields and a reduction in loss on the crop harvested that year. This was especially noticeable in those plantations where the pest was the worst and where efforts to establish the Tachinids had been concentrated at the outset.

On one of these plantations where the manager was keeping definite records, and the usual infestation by borers was about 30 per cent of the canes, in 1913 it had dropped to an infestation of but 12.77 per cent.

On this same plantation the quality of the juice has improved from this reduction in amount of infested cane, so that the number of tons of cane required to make a ton of sugar has become reduced in successive years as follows:

1911—11.04 tons of cane to make a ton of sugar.
1912— 9.95 " " " " " " " " "
1913— 9.54 " " " " " " " " "
1914— 9.37 " " " " " " " " "

Thus the reduction in the borers has resulted in a greater yield of good cane per acre, and by the quality of the juice being improved the yield of sugar per acre was further increased.

This increased yield per acre is not all to be accredited to the reduction in the borer, for there are always the weather and other factors which influence the yields in successive years; but in this case the manager attributes it chiefly to the reduction in borers by the Tachinid flies.

Another plantation that has been benefited in a similar manner reported an increase of .98 ton per acre in average yield of sugar for the 1913 crop, which would mean a saving of $75 to $90 per acre, according to the prevalent price of sugar. Where the plantation was harvesting 1000 acres this would equal $75,000 to $90,000 for the plantation. A further increase of 1.25 tons per acre was reported for the 1914 crop, which would more than double the above annual saving.

As indicative of the effective work of the Tachinids in reducing the borers, the following figures from one of the larger plantations where it has been customary to employ boys to collect borer beetles at a given fee per ounce, are of special value:

Borer beetles collected, 12 months ended June 30, 1912......27,010 oz.
" " " " " " " " 1913...... 3,414 oz.
" " " " " " " " 1914...... 1,568 oz.

The figures do not represent the actual reduction of borers, because the incentive for collecting them becomes less when they are harder to find, but they do show that there has been a great reduction in the borers on this plantation since the establishment and spread of the Tachinids throughout the fields.

Not all plantations have been benefited to the extent of these few given as illustrations, for not all were formerly so severely infested as these particular ones were, but quite a number have been very considerably benefited, while others have been in less degree. The total saving to the sugar industry would amount to a good many thousand dollars annually.

Comparison of the total annual production of sugar the past six years (1907-1914) is quite significant. The crop for 1914 was 21,780 tons greater than any previous crop in the history of the sugar industry of the Hawaiian Islands—the previous largest crop being in 1912. Averaging the crops for the last three years it is found that they exceed by 46,675 tons the average of the crops of the three years previous.

Comparisons of average yield per acre also show improvements the past few years, the yield for 1914 being 5.43 tons of sugar per acre.

The large increase in annual crop is partially due to increased acreage, better methods of culture, favorable weather conditions, etc., but it is generally recognized that the reduction of the borers by the introduced Tachinids has played a very important part.

PRESENT STATUS OF THE TACHINID.

There is no doubt but what the Tachinids have reached their maximum efficiency; that is, no further reduction of the borers by them is to be expected. The Tachinids themselves are at present less abundant in the fields than they were shortly after the time when they became generally spread. This is by reason of the reduction in the number of borers. Where the borers were most numerous, it gave the Tachinids a good chance to increase until for a time they were very abundant, but later became scarce corresponding to the scarcity of the borers brought about by them. In many places it is now difficult to find injury by borer where formerly much cane was injured, and similarly the Tachinids are difficult to find; but they have shown that they are able to find borers even where scarce, and are able to keep up their existence, for even where the borers are exceedingly scarce and hard to find, evidence of the Tachinids is also found.

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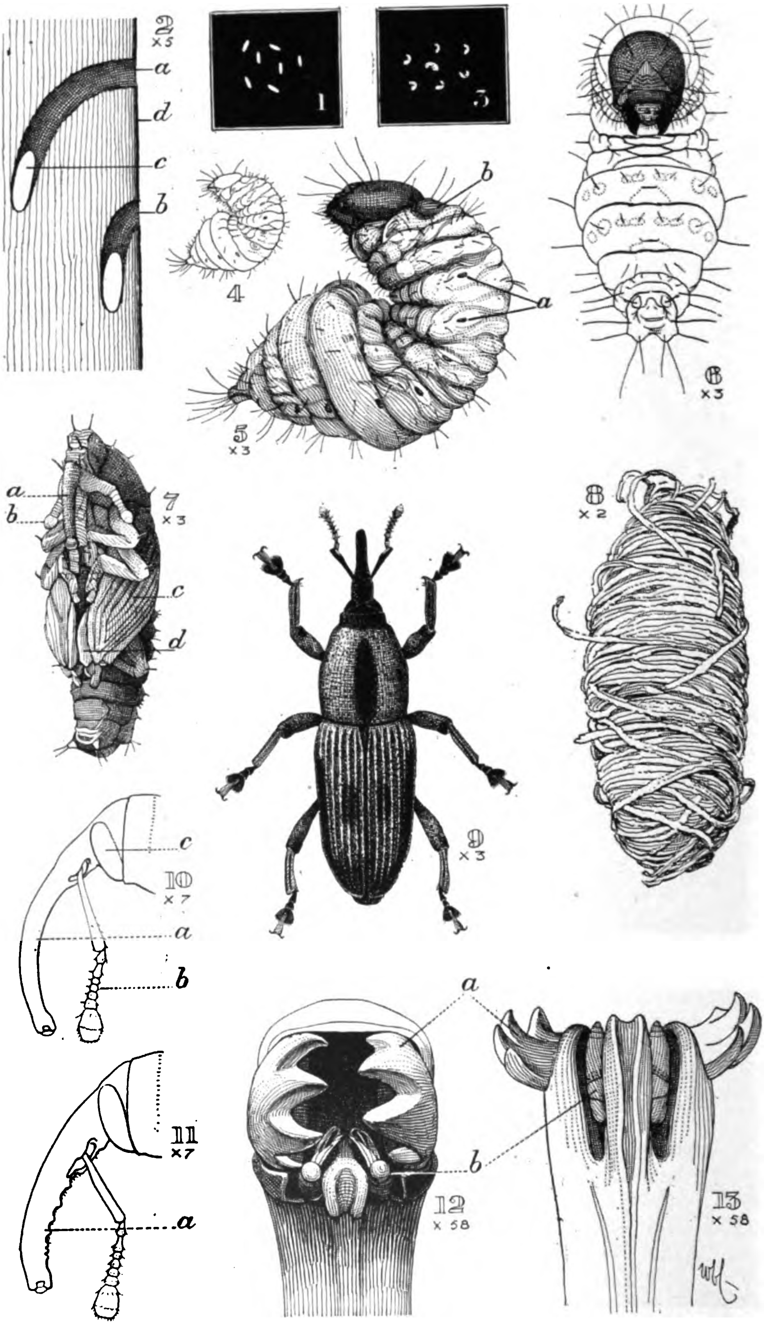


PLATE I.

PLATE I.

1. Eggs, (nat. size).
2. Eggs, (much enlarged).
    - *a*, section of egg-passage with egg *c*;
    - *b*, egg placed unusually near the rind;
3. Larvae, just hatched and older (nat. size).
4. Larva, adult (nat. size).
5. Larva, side view (enlarged).
    - *a*, spiracles;
    - *b*, cervical shield.
6. Larva, front view (enlarged).
7. Pupa, (enlarged).
    - *a*, rostrum or "beak;"
    - *b*, antenna;
    - *c*, elytron or "wing-case;"
    - *d*, wing folded up.
8. Pupa-case or "cocoon," (enlarged).
9. Fully matured male borer, (enlarged).
10. Head of female borer, (enlarged).
    - *a*, rostrum;
    - *b*, antenna;
    - *c*, eye.
11. Head of male borer, (enlarged).
    - *a*, rostrum.
12. Apical extremity of rostrum, (much enlarged).
    - *a*, mandibles, showing the sharp-cutting teeth;
    - *b*, maxillary palpi.
13. Extremity of rostrum, viewed from beneath (much enlarged).

BULLETIN XIII.

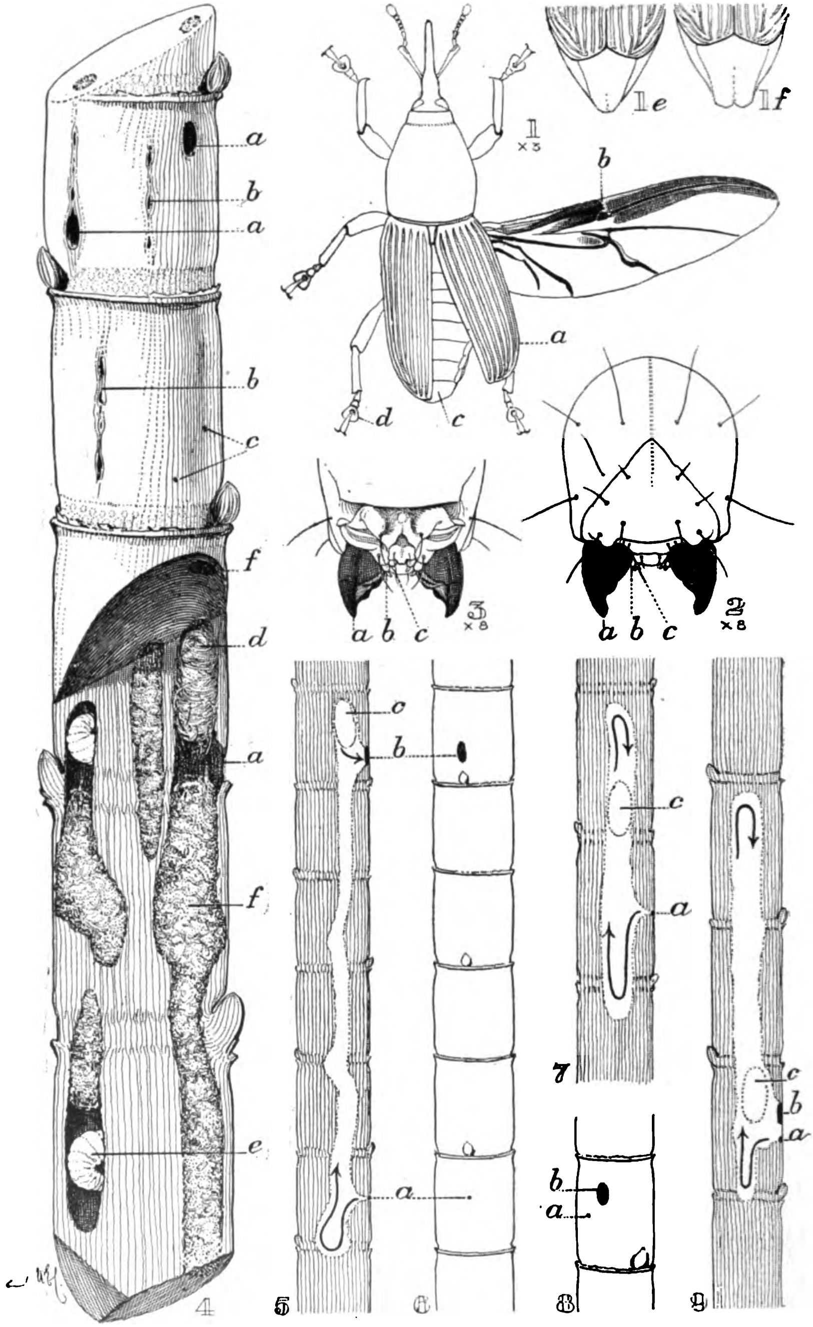


PLATE II.

PLATE II.

1. Mature female borer (enlarged).
    a, wing-case;
    b, wing, extended for flight.
    c, pygidium.
    d, adhesive pad of foot.

1*e*. Terminal segment of the abdomen (female beetle).

1*f*. Terminal segment of the abdomen (male beetle).

2. Head of adult larva, front view (much enlarged).
    a, mandibles.
    b, labial palpi "lip feelers;"
    c, maxillary palpi "maxillary feelers."

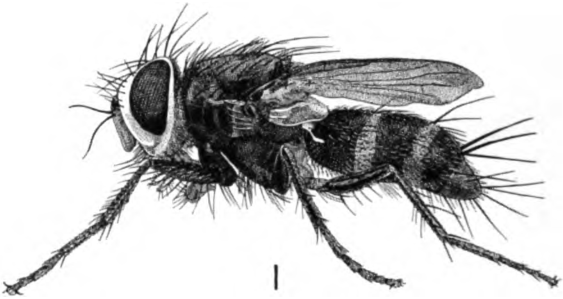
3. Mouth-parts of adult larva, viewed from beneath, (much enlarged), (*lettering as in* 2).

4. "Borered" cane stick (½ nat. size).
    a, "emergence" holes made by the larva before pupation;
    b, "*rupture*" holes, apparently accidental and made by the larva whilst feeding;
    c, "*entrance*" holes, made by the female borer for the reception of her eggs;
    d, cocoon;
    e, larva;
    f, "*frass*" or undigested cane fiber, passed by the larva.

5&6. Diagram A, sectional and external view:
    a, insertion hole;
    b, emergence hole;
    c, cocoon (*the arrow-head indicates the course taken by the larva*).

7 Diagram B (*lettering as in* 5&6).

8&9. Diagram C, external and sectional view (*lettering as in* 5&6).



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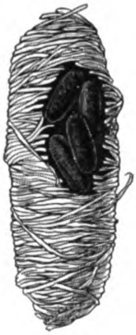

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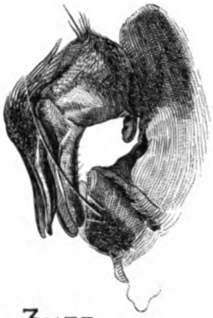

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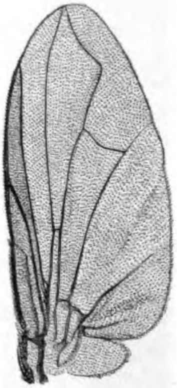

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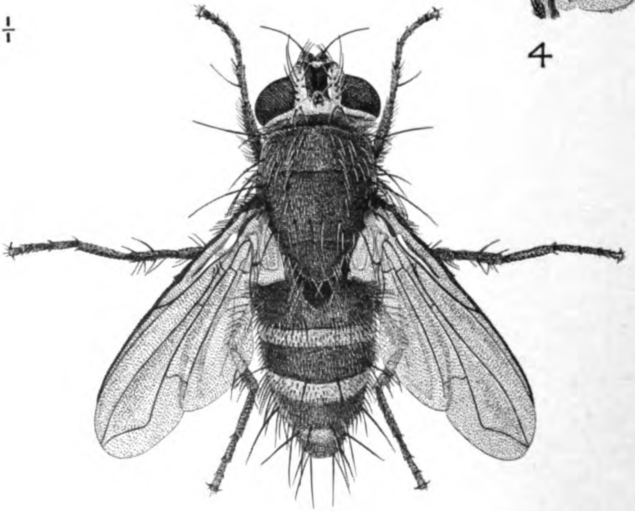

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W.R.R. Potter.

PLATE III.

PLATE III.

Fig. 1. Tachinid fly, *Ceromasia sphenophori*, side view.
2. Cocoon of borer with puparia of Tachinid inside.
3. Genitalia of male Tachinid.
4. Wing of Tachinid showing venation.
5. Tachinid fly, dorsal view.

APPENDIX A.—Printed as Circular No. 1, Div. Ent., Exp. Station, H. S. P. A., July, 1907.

Report on Investigations in South China.

By F. Muir.

Upon my arrival in Hongkong in the middle of August I made enquiries as to the situation of the sugar cane growing districts in South China. I was informed that it was grown in small patches all over South China, but eventually I learned that the greatest amount of sugar cane is grown in the Swatow district. Should I ever have to work in the Chinese sugar-cane fields again, I should make that town my headquarters in preference to Hongkong.

In Hongkong I was introduced to Mr. Li A. Pak, a Chinese gentleman who owns property at Castle Peak in the British or New Territory beyond Kowloon. This enterprising person has introduced several new fruit trees into his farm and has "Honolulu" sugar cane growing on his plantation. I availed myself of his offer of hospitality and spent a few days at Castle Peak Farm, visiting several places in the neighborhood where sugar-cane was grown. This was my first experience of Chinese food and chop-sticks. The weather was oppressively hot for field work; long distances had to be walked, as the sugar-cane patches were some distance apart. The early morning and evening sea-bath on the fine sea-beach at Castle Peak was the only enjoyable part of this trip. I was unsuccessful in my search for *Perkinsiella saccharicida* in this district on this occasion. In February, a few days before leaving China, I walked from the north-east side of the New Territory across the hills to Kowloon; in passing through a patch of sugar-cane I found some hopper eggs which eventually hatched out *Perkinsiella saccharicida*.

At the end of August I went across to Macao,* as it was a convenient place from which to make excursions to places in the lower part of the delta. I also wished to meet Mr. J. C. Kershaw, who had travelled and collected insects in South China for several years. By advice and assistance he rendered me great service during my stay in China. My search in this district for *Perkinsiella saccharicida* was also unsuccessful.

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* Macao is a small island on the opposite side of the bay from Hongkong, and should not be confused with Macao in Tongking.—G. W. K.

I now decided to visit the districts where sugar-cane was grown on a more extended scale, so in the middle of September I proceeded to Canton to procure a Chinese passport before proceeding up river. At first it was my intention to go up the West River, as its lower part is open to European navigation; but finding that more sugar cane was grown up the East River, I changed my plans and went by Chinese river-junk to Wei Chou.

This is the chief town in the prefecture of that name (Wei-Chou-fu) and is about 120 miles from Canton. It is a typical South Chinese town, and for narrow and dirty streets and smells repugnant to the nostrils of a "barbarian" was equal to any that I saw. The neighborhood has an evil name for turbulence, and some short time since the Viceroy personally visited the district to suppress a rebellion. Although I stayed some days here and went about freely in town and the surrounding country, yet I was never molested. This was my experience wherever I went in China, and the hospitality of "mine hosts" at the various monasteries I stayed at will always be a pleasant memory.

I wished to proceed beyond this place, but the great Typhoon at Hongkong had affected all the district, and rain had swollen the rivers so greatly that small houseboats refused to go up stream.

My first day's work in the sugar-cane in this district produced two new species of sugar cane leaf-hopper nearly related to *Perkinsiella saccharicida.* (These have since been named *Dicranotropis muiri* and *Perkinsiella sinensis* by Mr. Kirkaldy). My second day's work was rewarded by finding three specimens of *Perkinsiella saccharicida,* one of which carried a *Dryinus* sac on its back. This bred out a large black species very much like the Fijian species.*

Two days further search by myself and two Chinese boys only produced six more hoppers and one more parasite. Seeing that the parasites were much too rare in the district at this time of year to allow me to collect sufficient numbers in the fields to ship to Honolulu,I decided to return to a suitable place and breed them up in captivity.

To remain in Wei-Chou for any extended period was impossible, as there was absolutely no accommodation. A small houseboat, or sampan, is no place to work in, and a Chinese hotel in one of these towns is not at all to the taste of a "barbarian."

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* Owing to the absence of Dr. Perkins, who undertakes the systematic examination of Dryinids and Chalcidids, the names of these have not yet been determined.—G. W. K.

I returned to Canton, and eventually to Macao, as that town was the most convenient. I secured a room in the Macao Hotel with a large balcony, and planted several tubs of sugar cane, putting my hoppers and parasites under cover to breed.

Looking after my breeding cages and making trips to places up the river kept me busy till the middle of October, when I again went up the East River.

This time I went to Shek-lung, a large town about 70 miles from Canton. Both Chinese species of *Perkinsiella* were to be found in the sugar cane in this district, but very scarce, so I took a coolie to carry my bags and went north towards the Lo-fou mountains. From the banks of the river to the foot of the mountains, a distance of some 25 miles, the land is quite flat and given up to rice cultivation; rice is also grown in favorable valleys 1500 to 2000 feet up the mountains. Vegetable and sugar cane patches are found round all the villages. I continued round the eastern side of the mountain to Su-liu on the north. From this point I climbed to the top of the mountain with my friend, Mr. J. C. Kershaw, and spent two days in an old ruined joss house.

From the top of Lo-fou-shan grand views of the surrounding country could be obtained. To the south stretched flat rice fields to the river bank, on the other three sides granite hills rose from stretches of green and yellow paddy. These hills are without any distinct orientation, similar to the islands one sees round the Kwangtung (Canton) coast.

When looking across this country one is reminded of the fact that for hundreds of generations the Chinese have raised their two crops of rice each year, or their successive crops of vegetables, from the same land. There are few spots on this earth where continuous cultivation has been carried on longer than in this Kwangtung province. The question of keeping the land fertile by artificial means is therefore a very pressing one. Nothing that can serve as manure is allowed to go to waste. Sea shells are brought up by junks and crushed up and scattered over the land; every scrap of night soil is carted out of the towns into the fields; the residue from crushing pea-nuts for extract oil is made up into cakes and sold as fertilizer; everything, in fact, that can be put back into the soil is put back. I was asked many questions as to the possibility of securing fertilizers from America. If an efficient fertilizer, low enough in price to place it within reach of the small cultivator, could be imported, its consumption would be enormous. The Chinese farmer understands fertilizers, and would pay for a good one.

Naturally such a race of cultivators have had to contend against insect pests, and have found different remedies. A decoction of tobacco stems is used to kill various insects in their sugar-cane patches.

In the year 1833 the then Emperor of China issued an edict for the destruction of locusts; one of the remedies ordered was the letting off of guns, clanging of gongs and firing of giant crackers.*

The entomological conditions of the sugar cane in all this district were the same, so I returned to Shek-lung, collecting as many hoppers as possible on the way, and took boat for Canton and Macao, where I arrived on November 9th. This trip produced the second parasite on *Perkinsiella saccharicida,* a small black *Dryinus* with red thorax.

On the 22nd of November I again went up to Shek-lung to examine the sugar cane to the south and to procure more eggs, as I was not quite sure of the species of parasites infesting them.

In the middle of December I went up to Canton and made trips to the surrounding fields and a trip up the West River.

By these several trips I was able to examine the sugar-cane over a large area and under various conditions, which enables me to speak with some authority upon the various death factors that keep *Perkinsiella saccharicida* and its allies in subjection and prevent them from doing any material harm.

The chief of these factors are egg parasites, which appear to be the same species as in Queensland and Fiji. Seventy per cent. of the eggs were found destroyed. Owing to the scarcity of material this calculation had to be made on lower figures than I like; with higher figures, I believe the percentage would rise.

Next in importance come two species of Dryinidae. It is interesting to note that although the egg parasites on *P. saccharicida* and *P. sinensis* are the same, *P. sinensis* appears to be free from *Dryinus,* the two species that attack *P. saccharicida* never developed on *P. sinensis,* even when they stung them—a thing they very seldom did even when confined together in a breeding jar.

I forwarded several lots of these two parasites to Honolulu, and hope to hear soon that they have established themselves in the Islands.

Two or three species of lady-birds were often seen in the sugar-cane, a small red one that fed upon aphis and young hopper being the most plentiful. This one I saw again in great numbers in the rice fields in the Federated Malay States keeping the rice clean. It should prove a beneficial insect to Honolulu. Other species of ladybirds were also forwarded which were of direct or indirect benefit to the sugar-cane.

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* See S. W. Williams' "The Middle Kingdom," vol. I, 469-71.

Spiders and earwigs were everywhere in the sugar-cane, and play their part in keeping down other insect life, but their value can be easily overestimated, for, like the rain, they descend upon the just and the unjust alike.

I found *P. saccharicida* in the sugar cane in Province Wellesley and the Federated Malay States, but it was scarce. A large percentage of the old egg spots bore parasite holes, showing that the death factors at work were the same as in China.

In discussing the rarity of an insect, it is too often assumed, with little or no evidence, that climatic conditions are the ruling factors. In countries with very cold or very dry seasons, no doubt numbers are killed, especially when the cold or dry season is later or earlier than usual; but the great adaptability of insects to their climatic environment saves the vast majority from death by these agencies. In the case of *Perkinsiella saccharicida* we see that the agents that keep this in subjection are the same in Australia, China, the Malay Peninsula and Java; even the same species of parasites, or very near allies, are at work in these vastly different countries. The same parasites, or nearly allied ones, are at work upon *P. vitiensis* in Fiji, *P. sinensis* in China and *P. vastatrix* in Java. Even the predators that are at work in these several countries belong to the same groups. These are encouraging facts, for they give us every reason to believe that the same factors will work equally well in the Hawaiian Islands. Some of the conditions of agriculture necessary in the Hawaiian Islands, such as burning off large areas, are inimical to the parasites, but this can be counteracted by artificial distribution.

An interesting case came under my obesrvation showing the death factors of a moth (*Metanastria punctata*). The larvae of this moth appear at irregular intervals in local patches and defoliate the fir trees. At one time the Hongkong Government paid natives for collecting the larvae, but now this practice is discontinued as it was noticed that the pest always disappeared and did no permanent damage to the trees. When collecting with Mr. Kershaw, on the property of Chun A. Foong at Chin San, some miles outside Macao, we found a patch of fir trees, about a quarter of a mile square, infested with these insects in egg, larva and pupa stages, mostly pupae. Of the eggs I took, fifty per cent. hatched out Chalcid parasites (No. 212), and out of 317 pupae examined, 232—or over 73 per cent.—were destroyed by fungi or parasites, a Tachinid fly being most numerous (No. 229). On another occasion we brought up the number examined to over a thousand, and the same high percentage was obtained. The body of the female moth is always greatly distended with eggs, which are well developed in dead specimens taken from the pupa case. In one specimen so taken I counted 220 large eggs. If we use these figures, we will see that after the attack of the egg parasite (No. 212), 110 larvae will hatch out, and about thirty of them will escape the larva parasites and fungus. This leaves twenty-eight to be killed off by predators in the larva stage or before they lay eggs, and it is only upon these twenty-eight that the selective action of birds, lizards, etc., can act. Of course, predators will destroy more than this, for they will eat parasitized and unparasitized larvae alike. Thus we see that in the struggle for existence of these moths, parasites play by far the largest part, and the adult moth can be but little persecuted. These observations are of great interest from an economic point of view, from a biological point of view I also consider them of interest. That natural conditions are very much more complicated than here stated I admit, and many other factors come into play; the percentage of parasites will rise and fall, but an extended study of this insect, I feel sure, will show that parasites play the greatest part in regulating its number.

Florida red scale (*Chrysomphalus aonidum*) and the purple scale (*Lepidosaphes pinnaeformis*), so injurious to citrus trees in most parts of the world, are found in China in small numbers. Parasites are acting upon both these. I forwarded several lots of leaves and branches to Honolulu in hopes of establishing the parasites in Honolulu. Lucas' orange scale (*Parlatoria ziziphus*) is found in China in greater numbers than the two last mentioned, but it does no damage, being kept down by parasites. This was also forwarded in hopes of establishing the parasites.

A melon-fly, a near ally of our *Dacus cucurbitae*, attacks melons and cucumbers in China, but unfortunately I was too late in the year to study it, as melons and cucumbers were just over, and I could not find anything else affected by it.

I found a beetle very near to our Japanese beetle (*Adoretus umbrosus* var. *tenuimaculatus*) on some grape vines at Castle Peak, but I did not see them anywhere else. I could find no eggs or larvae at the time.

APPENDIX B.—Printed as Circular No. 2, Div. Ent., Exp. Station, H. S. P. A., October, 1907.

Notes on the Sugar-Cane Hoppers and Borers in the Malay States and Java.

By F. MUIR.

By the end of January I considered my investigations into the conditions of the sugar-cane leaf-hoppers in China completed, and having bred and forwarded to Honolulu such parasites as I deemed most important, I proceeded to Singapore, en route for Java.

As sugar-cane has been cultivated extensively for many years in the Wellesley province, and in small patches by natives all through the Malay States, I thought it advisable to pay that place a visit and make enquiries anent the sugar-cane borer (*Sphenophorus obscurus*).

This beetle was not represented in the collection of the Singapore Museum, and the Curator had no knowledge of its occurrence in the peninsula; neither is it represented in the Kwala Lumpur Museum, as Mr. Ridley, of the Singapore Botanic Gardens, whose knowledge of the fauna and flora of the peninsula is very extensive, told me he did not know of the presence of a *Sphenophorus* in the sugar-cane, but two species, *S. sordidus* and *S. ferrugineus*, occurred in banana trees.

In Kwala Lumpur I met Mr. Carruthers, Superintendent of Agriculture to the Federal Malay State Government, and Mr. H. C. Pratt, Economic Entomologist to the same Department. As they were about to visit Parit Buntar, just on the borders of province Wellesley and near to some large sugar estate, I accepted an invitation to accompany them. Mr. Carruthers furnished me with letters of introduction to the manager of one of the sugar estates.

One of the first insects I found in the sugar-cane, was our leaf-hopper (*Perkinsiella saccharicida*), which appears to be kept down by the same factors as in China, the majority of the eggs being parasitized. I did not find any species of Dryinids on it, but, as my time in this district was very short, I quite expect that one or more species exist and would be discovered by further search.

I could find no trace of the borer-beetle and it was unknown to the planters. A moth-borer is the worst pest they have, but, fortunately, the eggs are heavily parasitized. A ladybird, that I took to be *Cryptolaemus montrouzieri,* a species introduced by Koebele into the Hawaiian Islands, is very active in keeping down the Cane Coccus.

Lantana and the plant known in Fiji as "Koester's curse" (*Clidemia hirta*) are both common throughout the peninsula and usurp cleared ground. I could find no insects attacking them. The former does not grow so luxuriantly as in the Hawaiian Islands nor the latter so densely as in Fiji. As they have a much richer flora to contend with, they cannot make the same headway as they do in some other parts of the world. A species of coarse grass called *"lallang"* is the worst weed-pest they have, being very hard and costly to eradicate when once it has got into cleared ground.

The sugar industry of this district has greatly declined during recent years, as, owing to the scarcity of labor, it is unable to compete with Java. The advent of Para rubber, and the alluring prospects of big profits to be gained from it, are driving all other cultivation out of the field. Besides the large tracts of forest land that have been recently cleared and planted with rubber several coffee and sugar estates have been converted into rubber estates. At first rubber was confined to the higher land, but it is now found that the tree does as well in the low wet ground. The Malay States seem to be specially well adapted for this tree, and tapping is commenced 3½ to 4 years after planting.

Most of the labor in the Malay States has to be imported, China, India and Java being the sources of supply. Most of the Chinese go on to the tin mines, which are mostly owned by rich Chinamen in Singapore. The plantation labor is mostly Indian and Javanese.

Here, as in Java, the Chinese were the first to make sugar, and in many places they still have their primitive stone crushers worked by buffaloes or human labor.

I did not consider it advisable to prolong my stay here, as after visiting Java I could work the Malay States upon my way back if necessary.

I arrived in Java on the 10th March, and after spending two days in Batavia procuring a passport, visiting the Consul, Bank and shipping firm, I proceeded to Buitenzorg to present my letters of introduction and visit the Museum.

Buitenzorg is the seat of government. The offices, museum and laboratories of the extensive Department of Agriculture are built in, or near, the justly celebrated Botanic Gardens. I received great kindness from all the people I called upon, and their knowledge and experience were placed at my disposal. I was also furnished with letters of introduction to the Directors of the Sugar Planters' Experiment Stations in West, Mid, and East Java, and to other agricultural authorities in various parts of the island.

The sugar planters have three experiment stations. The West Java Station is situated at Pekalongan under the direction of Mr. H. C. Prinsen-Geerligs and is mainly devoted to chemical research; the East Java Station is situated at Pasoeroean under Dr. Kobus, and is mainly agricultural; and the Mid Java Station is at Djocja under Mr. W. van Deventer and is much smaller than either of the other two.

I spent ten weeks at Pekalongan investigating the sugar-cane leaf-hoppers and borers. Mr. Prinsen-Geerligs kindly procured me permission from the administrators of surrounding sugar estates to go over their plantations.

In the Pekalongan district the cane has a very even growth, and is very upright, the leaves being very clean and free from insect blights. Frequently the leaves are spotted and striped with yellow marks. The spots may be partly due to leaf-hoppers and other insects, *Phenice moesta* being common in many fields; the yellow stripe is more likely to be due to root disease.

I found three species of leaf-hopper allied to our *P. saccharicida.** None of these are numerous so they cause no appreciable harm. Egg-parasites are the chief factors in keeping them down, some appear to be the same as the Chinese species, or very closely allied.* Two forms are attacked by a Stylopid and the second form also by a Dryinid parasite. Spiders, labybirds, earwigs, and other predators, similar to what have been observed elsewhere, are fairly numerous, but the direct parasites I consider the chief cause of the scarcity of the hoppers. Thus we see that in Java the death-factors are similar to those in Queensland, Fiji, China, and the Malay States.

Some of these egg-parasites may be different from those that have already been introduced into the Hawaiian Islands, but it would take several months to separate the good from the bad, the parasites from the hyperparasites. The difficulty of introducing such delicate insects from such a distance, with two trans-shipments, is very great, so I did not attempt to forward any alive. Owing to fungus disease in Java cane fields, I made no shipments of living insects on growing cane.

Phenice moesta is the most common leaf-hopper observed by me in the sugar-cane fields. I did not identify the eggs or young, so I am not able to state what its chief death-factors are; a Stylopid parasite attacks the adult.

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* These have not been determined, on account of lack of opportunity.—G. W. K.

The larvae of three large beetles, *Xylotrupes gideon, Oryctes rhinoceros* and *Sphenophorus ferrugineus* are occasionally found living in the stem of the sugar-cane. These are all palm beetles, are very common, and do a large amount of damage to young palms. I bred a large number of eggs, larvae and pupae, but got no parasites from them. Woodpeckers and several small animals are fond of the larvae, but the chief death factors I found were the larvae of two or three carnivorous beetles.

The Hawaiian cane borer, *Sphenophorus obscurus,* is unknown in Java. I do not think it exists here as even if it were a forest insect it would have occasionally attacked sugar-cane, like the above mentioned three, and would have been reported. Two other species, *S. sordidus* and *ferrugineus* (or *S. maculipennis*) are fairly common in banana stems. Neither eggs, larvae or pupae have produced any parasites and the chief death-factors are the above mentioned carnivorous beetles. The chief of these is a large black Histerid that in the larva and imago stages feeds on the larvae and pupae of these borers. It is a most voracious insect, and, given the opportunity, it will suck several full-grown larvae dry in a day. It is also capable of undergoing prolonged fasts. The other carnivorous larvae are Hydrophilids. If these beetles will take to our sugar-cane fields, they will prove very beneficial in reducing our borer. I have forwarded some of them to Honolulu and hope shortly to hear of their safe arrival.*

The worst insect pests to the cane in Java are boring moth-larvae, of which there are several species. Fortunately their eggs are very heavily parasitized. A beetle larva of the genus *Anamola* also causes great damage in some parts of the island.

The sugar-planters are just bringing out a revised edition of their book on the insect-pests in their cane. The list is very formidable to look at, but, fortunately, for the industry in Java, few of the insects do any appreciable damage, parasites keeping them down.

Our "Japanese beetle," *Adoretus umbrosus,* exists in Java, but is very scarce. Up to the present I have not been able to procure either eggs or larvae. A prolonged search would be sure to reveal effective parasites or predators.

Red scale, purple scale, Lucas' black scale, and thread scale, all harmful in the Hawaiian Islands and elsewhere, exist here but are as scarce as in China. I think that the Oriental Region is the natural habitat of these world-wide scale-pests, from whence they have been gradually carried all over the world, mostly without their parasites.

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* The Hydrophilids all perished en route.

A mango weevil, said to be the same as the one in Honolulu, (*Cryptorhynchus mangiferae*), is common in some parts of the island but is said to be found in the fruit only, never in the seed, as in Honolulu. In Djocja a small weevil bores into the ends of the branches and kills them. *Dacus ferrugineus,* a near ally of our melon fly, attacks the mangoes. Mangoes are only just beginning to flower, so I am not able to procure any eggs or larvae of this fly.

Fungus diseases have been much worse foes than insects to the sugar industry in Java. So bad did they become that the planters were compelled to alter their method of cultivation and give up ratoon crops entirely. This, together with the land-laws of the country, has brought about a method of cultivation that is fairly uniform all over Java and gives excellent results.

The land-laws are communistic, the land belonging to the natives within each district; no one can purchase it from them, except small pieces for the erection of houses, mills and offices. It has therefore to be leased and the amount capable of being so leased in each district is limited to one-third, the other two-thirds being reserved for rice and other native products. In consequence of these laws, you find no large and compact sugar estates, the average being about 1,000 bouws (2,750 acres) and the size of the mills is limited. It is considered better to erect two mills of smaller size than to transport the cane considerable distances to one of larger size.

As no ratoon crops are taken, yearly planting is necessary, and, as only one-third of the land is available for sugar, a system of tri-annual rotation of crops is practised. Thus the same land is only under cane once in three years, the other two it is given over to rice and other native products.

As soon as the natives have gathered in their rice crops, between the end of April and the beginning of June, the sugar-planters immediately put their laborers into the fields they have leased for the following year. As soon as the cane is cut the land is handed back to the native owners. Thus no time is lost between crops whilst the land is being prepared.

On taking over the land, especially if it has been under rice, it is necessary to drain it. A ditch, about thirty inches by thirty inches, is dug round the edge of the field, which is generally in communication with natural or artificial water-ways; parallel ditches, about twenty-four by twenty-four inches, are run through the field ten yards apart; similar ditches are run across the field eighty yards apart, thus dividing the field into parallelograms of eighty by ten yards; except round the edges where the boundary makes them irregular. Across these parallelograms the seed-trenches, about eighteen by eighteen inches, are dug, with the centers four to five feet apart, according to the nature of the soil. This gives fifteen to nineteen trenches in each parallelogram. The earth from the trenches is banked up between them. The Javanese are good laborers at this work and a field in this condition, ready to receive seed-cane, has a neat and symmetrical appearance, whence arises the fanciful idea of a huge graveyard prepared to receive the giant heroes of an Armageddon.

By this system of ditches the land can be thoroughly drained, and, later on, when absence of rain makes it necessary, water can be let into the ditches and the land kept moist. Planting is done between May and July, the first part of the dry season.

Trench cutting is paid by the piece and averages about f. 0.35 (taking the dollar as 2.40 guilders, this would be 14½ cents).

Ground-nut refuse, after the oil has been pressed out, is used as manure. This is worked into the soil in the seed-trenches before the seed-cane is set. Two dressings of ammonia are usually given during the growth of the young cane.

Great care is taken in the planting of the seed cane, which is done by women paid f. 0.25 (about 10½ cents) per day. The seed-trenches having been prepared as above described, and watered, the *bibits,* or seed-cane, are set down the center of the trench, end to end, about two inches apart. The *bibits* are pressed into the soil flat with the "eyes" on each side, never with one "eye' above and one below. A couple of extra *bibits* are planted at the end of the row to use as supply for any that may die.

As the shoots grow the earth banked up between the trenches is used to fill them in gradually till the field is quite flat. Eventually the soil is dug from between the rows and banked up around the cane. Thus from starting to grow in trenches of eighteen inches deep, the cane ends by growing from ridges.

By this process the cane is given a good grip on the soil and grows upright, a thing that is considered of primary importance in Java. Experience has shown the planters that an acre of upright cane, although of less weight than an acre of cane that has bent down, produces more sugar. It is also believed by many that this deep planting reduces root diseases.

Where cane is planted in large areas it is generally the custom to divide it up into sections of early and late varieties. The earlier varieties are cut and cleared first, leaving the later varieties standing in isolated patches, and so minimizing the risk of fire, as the dry season advances.

The cane is not cut off close to the ground as is usually done elsewhere, but the soil is removed from round the root and the cane pulled out. A newly cut field has no stumps sticking up.

Great attention is given to the selection of seed-cane—called *bibit*. They speak of two kinds here, "*bibit generatie*" and "*bibit import*."

"*Bibit generatie*" is the tops of twelve months old cane, the lower part of which is milled. This is only taken from such cane as shows no trace of disease and, naturally, from a good sugar-yielding stock.

"*Bibit import*" is six months old cane that is grown in the mountains, where the soil is comparatively free from fungus diseases. This is set about November and December and is used entirely for planting. Most sugar-estates own their own mountain plantation for growing "*bibit import*" but there are also planters who grow this in the mountains and sell it to the estates; these planters also produce different varieties from seeds and put them onto the market.

Lately a system of selecting *bibits* by density has proved very successful. The denser the *bibits* the greater the yield of the crop. Water is thickened with molasses till it has a density of 3 brix and the *bibits* are thrown into it. Those *bibits* that sink are selected, those that float rejected. It is interesting to note what good "looking" *bibits* are rejected. By gradually increasing the standard of density the planters hope to improve the crop. If Bordeaux Mixture be used as a fungicide, one bath might do for both purposes.

The *bibits* are very cleanly cut,—you seldom see a split or jagged edge. It is generally conveyed to the field in bundles and placed under shelter. It bears two nodes and is generally about nine inches long. From thirteen to fifteen thousand are generally used to the bouw (2.75 acres). Experience has proved that thicker planting does not improve the yield per acre.

Abundant and cheap labor enables the Javanese sugar-planters to give such attention to the young cane as is not possible elsewhere. The cost of labor varies slightly in different parts of Java, but on an average, it is about 8½ gold cents per day in West Java, 10½ cents in Mid Java and 12½ in East Java.

Lantana grows freely on all uncultivated cleared ground all over the island. *Clidemia hirta* is common on the western end of the island. I could find no insect doing much harm to them, but they do not grow so luxuriantly as in Hawaii or Fiji. A tall slender cane called "*alang-alang*" covers uncultivated ground in some parts of the island and is exceedingly difficult to get rid of.

APPENDIX C.—Printed as Circular No. 4, Div. Ent., Exp. Station, H. S. P. A., February, 1908.

Entomological Work in Borneo.

By F. Muir.

In my last report I stated my reasons for concluding that our sugar-cane borer (*Sphenophorus obscurus*) did not exist in Java. I had, therefore, to decide on my movements.

Two courses lay open before me, viz: to study some allied species and send over parasites I might find upon them, in the hope that they would also attack our borer, or start in search of our borer in some other part of the Malay Archipelago.

To some extent I had already followed the first course by forwarding some *Histerids* and *Hydrophilids* that prey upon species of *Sphenophorus* in banana and palm trees. To have continued this course would have occupied months of work and probably ended with little or no gain; for parasites are fickle creatures, and, whilst attacking species of distant genera, often refuse to attack closely allied species, as was the case with *Elenchus* and *Perkinsiella vitiensis* and *saccharicida.*

Rather than do this I considered it would be better to proceed to some spot where our borer is known to exist, such as British New Guinea, where it was abundant some years ago, and is supposed to have been introduced. In this country native Calandrids are numerous, and if some of their parasites have not by this time transferred their attention to *S. obscurus* it is improbable that any chance ones I could send from Java would do so.

The alternative course, of searching for our borer in other parts of the Archipelago, is such a huge undertaking to carry out thoroughly that I could not contemplate it.

Before leaving Honolulu I had consulted all the works I could find on the distribution of this beetle, especially in this part of the world. It exists in most of the Pacific Islands to New Guinea and Tenimber, the latter being the most westerly point where it has been taken. I have been unable to get any further information, either from Europe or the Museum in Buitenzorg.

From Java to Tenimber is such a large field that it would be impossible to thoroughly search even a fraction of it. I therefore decided to try one or two spots, and so work my way to Tenimber Islands, making the search for *Sphenophorus obscurus* my chief aim, but also studying the death factors that keep this and allied genera in check.

I left Batavia on the 21st of July, 1907, by S. S. Alting, and landed in Pontianak on the morning of the 24th.

I was very fortunate in meeting two Englishmen on board, Messrs. White and Girdlestone, both residents of West Borneo. Through their kindness and hospitality I was enabled to visit two very different localities. The former is manager of the Tanadina Co., and lives at Teloc Ayer, a small island situated in the lower part of the Kapoeas delta; the latter has mining concessions at Moewong, in the Mempawah district, about seventy miles north of Pontianak.

Owing to the shallowness of the water on the bar large boats cannot enter the main branch of the river, but have to take a more southerly entrance, and steam for nine hours through winding channels, and enter the main stream a little above Pontianak. For the first two hours the sides of the channel are lined with nepa palms, forming a thick even wall; as you continue on the nepa thins out and various species of mangrove appear, and, where the land is a foot or two high, the banks are covered with lowland forest trees. The whole aspect is very tropical, especially where the rattans shoot their graceful tops above the trees.

Pontianak was a Chinese town before the Dutch came to the country, and most of the inhabitants are still Chinese, through whose hands most of the trade passes. Copra oil is the chief product, there being two mills for the manufacture of this product.

The town is situated on the western side of the river on low swampy ground, a most unsuitable site; the roads are all reclaimed ground, and so is the ground that a few of the houses stand on, the majority being built on wooden piles, and having a couple of feet of water under them at high tide. The town is intersected by numerous ditches along which natives move in small canoes at high tide. I was surprised to hear that such a situation was healthy. During my stay I was never troubled by mosquitoes, but I was informed that at times they are exceedingly bad.

At the back of the town the Chinese have cleared a good deal of ground, and grow various market garden products. Sugarcane is also grown in fair quantities for market and making into sugar. The cane is crushed in stone mills, and boiled in open pans in the same primitive manner as in China. On the eastern side of the river some of the forest has been cleared and a small rubber plantation started.

All the land around here is low, and belongs to the delta formation. The soil consists of a soft forest peat six to ten feet thick when first cleared of trees, but it soon sinks when exposed to rain and cultivated. The water drained from this peat land is of the color of strong tea. After heavy rains the river Kapoeas is strongly colored by this peat water, and the sago washed with it acquires a dirty color. It is not unhealthy to drink.

I remained a few days in Pontianak, examining the sugar fields in the neighborhood, and searching in places likely to produce *Sphenophorus obscurus.* In this search I was not successful, but I found *S. sordidus* and *ferrugineus* in the banana and palm trees, attended by Hydrophilids and Histerids, as in Java. I also found these predators in the runs of a borer in pandanus. No direct parasites rewarded my search.

I was interested to find a species of Perkinsiella (*P. vastatrix*) on the sugar-cane. Its eggs were parasitized by a Mymarid (No. 382) very like the one in Java. I also took the young bearing Dryinid sacs, but failed to breed them out. A moth borer was the most harmful insect I noticed.

A species of Dacus (No. 380) was very abundant on cucumbers, and did great damage. I hatched out many eggs and pupae, but got no parasites.

As I wished to visit some of the native villages on the delta, and to search among the pandanus and other swamp loving plants, I accepted an invitation from Mr. White to visit Teloc Ayer, and went down in his steam launch. We started at 6 p. m., and arrived about 7 a. m. the next morning.

The river by night had a very different aspect than when I went up by day. The night was very dark, and innumerable fireflies illuminated the vegetation along the banks. In some places thousands had congregated together, and all kept time in the pulsation of their light; in other places a cloud of them would move rapidly up and down the bank, at one time bunching all together, and then trailing off like the tail of a comet. The larvae of these beetles are very interesting creatures, some attaining three inches in length. All that I took inhabited old trees and rotten wood, where they prey upon other insects. One that I kept alive in Java entered the runs, and fed on the larvae, of beetle borers. They do not devour their prey, but suck their juices, a process their mouth is specially adapted for. The mandibles are long and pointed, with a groove down the center, the mouth is closed below by a greatly developed hypopharynx (?), and the maxillary palps large and used for grasping its prey. The antennae are thick, reminding one of the eyestalks of a snail, and are capable of being withdrawn into the head. The head is also capable of being withdrawn into the pronotum. Few of these larvae have been reared and identified; one that I bred had fully winged male and female, and the mouth parts, although greatly reduced, were very like the larval forms. Each segment of the body bore a lateral process, articulated at the base.

The delta formed by the Kapoeas, Landak, and some smaller rivers, is of large extent; the land is low and flat, with innumerable channels cutting it up into small islands; mangrove is the chief tree, especially in the lower parts of the delta. A few isolated hills, of a sandstone formation, with occasional quartz veins running through it, stand out from the general flatness of the country. These hills are covered with large forest trees different from those of the surrounding swamp.

Teloc Ayer is such a hill, forming a crescent, looking east. The forest along the shore, between the points of the crescent, has been cleared, and the factory built near the beach. A stream of good water comes down from the hills and supplies the factory. This stream has given the name to the island (Teloc, bay—Ayer, water), native boats having made this a place of call for getting fresh water.

The majority of the "cutch" (catechu) manufactured here was shipped to America, but a recently imposed heavy duty has closed this market. Should the customs duties ever be abolished, or lowered, in favor of the Philippines, this industry would be very profitable there.

Mr. White's home is situated on the northern point of the crescent, and looks toward the east. From it one gets a fine view of the surrounding country. The tops of the mangrove trees form a flat, green surface, cut up by channels; where the water is not visible its course can be followed by the light green of the nepa palm growing along its edge. On a clear day one can distinguish the Sockadana hills some fifty miles away. This flat view may have charms for a visitor, but becomes a monotonous sight to those few Europeans living there.

One of the few forms of excitement here is keeping chickens, not that this in itself is very exciting, but when you go to get your breakfast eggs and find a fifteen-foot python curled up in your hen house, lazily digesting two or three of your chickens, it adds to the excitement, if not to the profit, of poultry rearing. We caught one such in Mr. White's hen house while I was there. My boy got its head through a slip knot and dragged it down to the factory, where it was skinned and tanned. Its intestine, like so many snakes in this part of the world, was full of parasitic worms.

I found a few clumps of sugar-cane growing near the factory, on which I took *P. vastatrix* (?) and its attendant egg-parasites (No. 382). These insects I found wherever I went in West Borneo. These parasites are the main factors keeping this hopper in check, and appear to be very efficient. I could find no trace of a beetle borer in the cane, but in the pandanus a large one was present, probably a *Rhynchophorus.* I found some of the larvae dead, and the large puparium of a dipterous insect in the run, by all appearance a Tachinid; I did not succeed in hatching out any, although I kept a great many in confinement.

Before leaving Java I had obtained the services of a native collector, who had worked a long time for the Buitenzorg Museum. I soon recognized the value of his services, as between 11 a. m. and 4 p. m. I generally found the heat too great to do much field work.

I spent twelve days in this district, and then returned to Pontianak. Here I met Mr. A. J. Simons, an Englishman, with whom I travelled from Singapore to Batavia. He invited me to visit him at Sockadana, situated on the coast to the south, but having just returned from a similar locality, I considered it best to get inland, so I accepted an invitation to visit Mr. Girdleston at Moewong. To reach this place is a three days' journey, the first by canoe, and then two days' walk.

Having procured letters, through the kindness of the Assistant Resident of Pontianak, to the Captains of the Chinese Kampongs through which I had to pass, I started at 5 p. m., so as to benefit by the tide.

My canoe was about 40 inches wide, and about 18 feet long, covered with a bamboo frame, thatched with palm leaves, except at the bow and stern, where the two natives, who formed the crew, sat and paddled. After stowing away my baggage there was little room left for myself and boy.

The first few miles our course lay eastward, along the Landak River, then we turned off into the Mandor River, and proceeded north.

The banks are low and covered with lowland forest trees; pandanus grows abundantly along the edges, in many places forming a solid wall seven or eight yards thick. About nine o'clock a thunder-storm came on, and my men tied up under the shelter of such a wall. These rivers are said to be full of crocodiles, but I only saw one. It would be inconvenient to be upset in such a place, as one might have to swim a mile or more to find a landing place; to get through the pandanus to the bank would be almost impossible.

I was agreeably surprised not to be troubled by mosquitoes in such a situation; in Fiji, whenever I passed a night upon the river, I was nearly driven mad. During the day we were all troubled by several species of Tabanidae, or "Dyak flies," as they are called locally. These flies are exceedingly numerous, and follow the boat for miles. One large specimen, with a very decided clip out of its wing, flew round the boat for four hours, occasionally settling on one or the other to feed. There is very little cattle disease in this part of Borneo, and I did not hear of any severe plague among them, but a few months before my visit an epidemic killed off the majority of the dogs in this district. No doubt trypanosome would be very quickly carried through the country by these Tabanid flies.

In the rainy season one can go up to Mandor by boat, but at this time of the year the water is so low that one cannot go past Koeping; even to reach that point the crew had to get out on several occasions and push the canoe over sand banks. In the higher part of the river the trees often meet over the river. Old fallen tree trunks block the stream, and masses of pandanus and other water plants form islands, only leaving small passages through which to navigate the canoe.

We did not reach Koeping till 11 a. m., and then I had to wait for an hour and a half before I could get a couple of Chinese coolies to carry my bags to Mandor, about twelve miles farther on. Koeping consists of about four houses, where half a dozen Chinamen live. The road between this place and Mandor is good, and runs through fairly old forest, parallel to the river; in the shade of the forest the ground is covered with moss, and the atmosphere is cool and damp.

The great number of "stick-insects" (phasmids) and the scarcity of butterflies was very noticeable.

Mandor is a Chinese village consisting of one long street. Travellers arriving here and wishing to get coolies to go up country or a boat to go down the river are charged exorbitant rates, and as there is no one else to go to, you have to pay. Fortunately I had letters from the Assistant Resident, and so had less trouble than I otherwise would have had, but I had to pay more than a righteous charge. I spent the night here, and started at daybreak for Karagnan.

Soon after leaving Mandor the country becomes hilly, and large timber disappears. In all this part of Borneo one only finds primitive forest on a few isolated tops of mountains, where the

Dyaks, partly out of superstition, have not burnt it. The same thing is mentioned by Dr. A. W. Nienwenhuis in his journey through Borneo. The Dyak method of agriculture is responsible for this. Near the end of the dry season they clear a piece of ground by burning the trees, and then sow their rice, which comes up with the rains. After one crop of rice has been taken from the soil the spot is abandoned and not used again for six or seven years. Although the Dyaks are very few in number, yet succeeding generations have cleared the country of large timber. Borneo possesses many valuable trees, some on account of their resins, others for building or cabinet making; properly conserved, the forest would be much more valuable than the miserable crops of rice raised on the cleared spots.

The Chinese were in this district washing for gold long before Europeans. The extent of their workings is marvelous, and cannot be believed unless seen. For miles the whole face of the country has been changed by diggings and sluices, and whole hills have been "washed" away.

About 11 a. m. we reached a small Chinese village situated on the Mempawah River, which is fairly large here, and has to be crossed in a boat. Soon after this the road becomes bad, and is only a track through the bush a great deal of the way. At half past three I arrived at Karagnan, two hours earlier than I expected. I stopped the night at this small Chinese village, and started early in the morning.

As the road passes through so many streams, I decided to walk in pajamas and shoes. By this means I enjoyed many a pleasant bath with little trouble.

A Dyak bridge is not at all a nice thing to negotiate. Sometimes it consists of a tree trunk thrown across the stream; sometimes a few bamboos lashed together into a bundle, with a rattan stretched as a hand rail. The bridge sways about from side to side, but should you try to steady yourself by aid of the hand rail your fall is inevitable. Personally, I prefer to wade.

Sugar-cane grew in patches around all of the villages, and in many spots in the bush, probably the sites of old Kampongs. I made many halts on the way to examine these patches, but found no traces of beetle-borers.

Toward noon the road became more rugged and the ascent steeper, as we follow up the Mempawah River between Pandang and Sekeh mountains. We passed several Dyak villages, built on platforms raised on wooden piles four to five feet above the ground, with a notched trunk of a tree for steps to reach it. The stench that rises from the mud and filth that accumulate below is abominable. A "village" generally consists of one such platform, with one building divided off into compartments, with one larger general compartment for cooking, etc. The size of a village is estimated by the number of doors. Sometimes the road passes through a Dyak village, and then one must climb up the notched tree trunk, pass through the village, and down the other side.

A steep climb up the side of the Moewong mountain brought me to my destination about four o'clock, where a bath and a drink put me in a frame of mind to appreciate the view which lay stretched out in front of me.

The mountains form a circle, with a break towards the southeast. On the eastern side of the break rises Mount Sekeh, about 3,000 feet, on the western side, Mount Pandang, a little over three thousand feet; Moewong, about 2,700 feet, is in the center. The Mempawah River rises within this circle of mountains, and passes out between Sekeh and Pandang. The sides of the mountains are covered with fine old trees, thickly covered with orchids and climbing plants. My friend's house is situated about 1,500 feet up the southern side of Moewong. Even at this slight elevation there is a distinct difference in climate; the evenings and nights are cool, and one must sleep under a blanket. During the day one can walk around and collect without real discomfort. From his balcony one looks between Pandang and Sekeh, over the Landak district, which stretches out like a map, ranges of hills stretching in all directions. In the early morning, before the sun has dispersed the mists in the lowlands, it looks like a sea dotted with islands.

In this spot I spent two weeks, and would willingly have spent two years. It is a rich entomological field, where an entomologist could spend a life time. I took several species allied to our cane borer, but not our species. I found Histerids and Hydrophilids at work on several of the larvae, but got no direct parasites; but as both eggs and larvae were exceedingly scarce I could get little material. A whole day's search would only result in a few eggs or two or three larvae. A large patch of cane was growing near a Dyak Kampong at the bottom of Moewong, but I found no borers attacking it. *Perkinsiella* and its parasites were also present, but not in numbers. Some specimens of *Diopsis* I took were 7 mm. long, and about 14 mm. from eye to eye. This lateral drawing out of the head is not confined to *Diopsis*, for a Trypetid about 9 mm. long measured 13 mm. from eye to eye, but the eye stalks are much thicker than in *Diopsis*, and the antennae near together.

The gold mine they are at present working is on the eastern face of Moewong, and the mill is situated about 300 feet below the house. Good copper ore exists at Pandang, but has not yet been worked. Dutch Borneo has been unfortunate in its mining, not so much on account of the nature of the ore, for a lot of it runs from one to one and a half ounces to the ton, but on account of mismanagement and want of capital. Were all the mining rights in West Borneo amalgamated, they could be run much more economically and profitably.

I was surprised to find that the Dyaks possessed a knowledge of metallurgy. Not only can they recognize metal bearing ore, but they understand the process of baking and extracting the metal. The Chinese only work alluvial gold, so I do not think they can have learnt from them. The temper of their steel is of a high quality, and a good "head cutting" knife is reported capable of cutting through an iron bar; they are also cleverly inlaid with brass, and sometimes with gold. As far as I observed the only heads they were keen on getting were Queen Wilhelmina's stamped on a silver coin.

A day before I left we had heavy rains, which made the roads bad and all the streams swollen. Leeches, which were bad before, were now much worse, and my coolies had to be continually stopping to clear their legs of them.

On my way down the river I made several stoppages to examine the pandanus for *Sphenophorus*, but without success.

I left Pontianak on September 8th, by S. S. Alting for Batavia, from whence I proceeded to Buitenzorg, to get together another lot of Histerids and Hydrophilids for shipment.

APPENDIX D.—Printed as Circular No. 6, Div. Ent., Exp. Station, H. S. P. A., May, 1908.

Report on the Search for the Sugar Cane Borer in the Malay Archipelago.

By F. Muir.

In the report of my trip to Borneo I stated my intention of visiting certain places in the Malay Archipelago in search of our Cane Borer (*Sphenophorus obscurus*). I first went to West Borneo, as already described, and, having been unsuccessful there, had to decide upon my next move. This should have been the Celebes, as the next place to the east. Several collectors have been to various parts of that island and, as far as I know, have not taken our beetle, so I decided to go still further to the East.

My present search for *Sphenophorus obscurus* is based upon the assumption that the natural home of our Cane Borer is either the western or middle part of the Malay Archipelago, and that there it is an uncommon, or rare, insect, its numbers being kept down by natural enemies. From this place it has traveled eastward, unaccompanied by its natural enemies. It is possible that this insect accompanied the natives in their migration eastward in the coconuts, sugar cane, and other food-stuffs that they always carry.

Instead of following it up from the west, I decided to cut its route and follow it back. In British New Guinea and the islands to the east it is reported very common and destructive. I had therefore to look to the west of this locality. The only place where I knew of its existence west of British New Guinea was Larat, in the Tenimber or Timor Laut group. Forbes took it at Larat some years ago, but as his collection of beetles was very small, and contained mostly common forms, I did not expect to find it a rare beetle there. Still, Larat was a necessary point from which to work back.

Amboina, or Ambon, as it is generally called, being the seat of government for the eastern part of the Dutch Indies, and the center for the mail service in those parts, formed a good center to work from.

Before leaving Buitenzorg, Dr. Koningsberger furnished me with a letter of introduction to the Resident of Amboina, Baron Quales de Quales.

I left Batavia on the 1st October, 1907, in the Dutch mail boat "Mossel," calling at Bally, Macassar, Tifoe (in Boeroe) and arriving at Amboina on the 9th.

In Macasser I was introduced to a Dutchman, who has a plantation at Boelabai, in Ceram. He was going to Java and expected to return by the next boat. He offered to take me over with him and put me up on his plantation. Such an opportunity was not to be missed, so I arranged to wait in Amboina for two weeks and meet him upon his return. An unfortunate accident detained him in Java and our arrangements fell through. This kept me in Amboina longer than I had originally intended.

When I called upon the Resident and presented my letter of introduction he offered to do anything in his power to help me. He introduced me to Mr. J. D. de Roock, the Controleur of Amboina, and requested him to take me with him on his official visits to the various villages on the island. By this means I visited the greater part of the island, spending many a pleasant day with Mr. de Roock, traveling by boat round the coast, or on foot over the mountains.

Amboina consists of two parts, joined together by a narrow isthmus near the eastern end. The northern part, called Hitou, is the larger, consisting of 613 square kilometers, whilst Leitimor, the southern portion, consists of 148 square kilometers. The whole island is very mountainous, especially the eastern portion of Hitou, where the mountain of Salahoetoe rises 1027 meters. The coast round this portion of the island is steep to the water's edge, covered with dense tropical vegetation, giving the scenery a touch of grandeur I did not notice elsewhere in the island. Lomoe Lomoe, 748 meters; Latoea, 882 meters, and Hista Kapal, 830 meters, are the next highest points in Hitou, all covered with old timber. The town of Amboina is situated on the northern side of Leitimor, with the mountain Nona (514 meters) to the southwest looking very bare, as it has been cleared of all its old timber. Horiel (562 meters), towards the southeast, is also bare on its lower slopes, the old timber being confined to the higher ridges. The only means of getting about in the mountains is by walking, the roads being steep and rough in many places; around the coast one can go by boat. There is a great deal of fine scenery, especially from the higher ridges looking over the tropical vegetation to the deep blue sea beyond.

The geology of Amboina points to it having once been joined to Ceram, although the sea between is very deep, but the connection was very ancient. The mountain mass of Salahoetoe is considered to have been an ancient volcano; volcanic rock of a more recent date is also visible in places, but no signs of active volcanoes now exist. The whole region is subject to earthquakes; the last severe one was in 1898, when the town of Amboina was wrecked.

The Amboinese are considered the best native soldiers in the Dutch Indies. One would never accuse them of this warlike spirit if one had only seen them in their native villages, where they are a peaceable and pleasure-loving people, fond of music, singing, and dancing. Like many of the native races scattered over the Pacific, they have a good ear for music; even the monotonous beating of their tomtoms as they row their boats is in perfect time. This rhythmical noise used to hypnotize me and make me sleepy, but under its influence the rowers will keep up a steady stroke for a long time.

The Portuguese influence is very noticeable both in the features and names of the natives, Lopies, Qualio, Silva and other Portuguese names being very common.

At all the villages I visited, Mr. de Roock inquired through the Resident, or chief of the village, if a beetle was known to destroy the sugar cane. I also exhibited specimens. I met with a negative answer from them all. Sugar cane is grown at all the villages for eating. It is very healthy and free from any bad blight. A species of our leaf-hopper (*P. vastatrix*, No. 385) is always to be found, also another dark-colored hopper, which I likewise took in sugar cane at Toeal and Larat. The eggs of these are heavily parasitized, the adults being free from parasites, as far as I observed. Several species of *Pipunculus* and *Dryinidae* were found on hoppers. Unfortunately the latter did not stand the trip to Larat, so I hatched out very few. *Stylopids* were also in hoppers, but I did not hatch any males out. One species is attached to a large red *Scutellerid* bug. The larvae of a *Lycaenid* (209) and a small moth (411 and 429) were found feeding on a white scale. Various ladybirds will be found among my collection, together with their hosts.

My search for *Sphenophorus obscurus* was chiefly in the sugar cane. I could find no sign of a beetle-borer, but a moth-borer is sometimes present. Pandanus was the next place of search for beetle-borers. In this I got a large black borer, not at all like ours. Bananas contained *Sphenophorus sordidus*, accompanied by a Histerid and Hydrophilids. Two or three smaller borers are common in palms of various sorts. Pandanus is a nasty tree to search in, on account of the hard spiny leaves.

Having failed in my search in Amboina, and my trip to Ceram having fallen through, I decided to take the next boat to Larat, as I had originally intended. The Resident of Amboina supplied me with a letter of introduction to the Controleur of that district, who resides in Toeal, in the Kei Islands; also a letter to the postholder at Larat.

I left Amboina on the 23rd of November and, after calling at Barda, Toeal, and Dobo, arrived at Larat on the 29th.

Larat is the name of the third largest island of the Tenimber group, being separated from Jamdena by Wallace's Channel. There is no village of that name, although one is often marked on maps. The mail boats lie off the village of Watidal, situated at the western end of Wallace's Channel. It consists of a few small stores, kept by Chinamen or Arabs, and some native huts, built on a strip of sand between the sea and a cliff about 60 feet high. On the higher ground are the native villages of Ridoel and Ritabel. The village of Lelingloewan, which is roughly quoted as the place of call by the shipping company, is a small island the other side of the bay.

Upon landing and introducing myself to the postholder, Mr. Sigers, a native of Amboina, I was glad to hear that he could accommodate me in his house, where I could also get my meals cooked. This saved me a great deal of trouble and discomfort, as a native hut is not a place where one can work, or even sleep, in comfort. The house is situated behind the village of Ritabel in a bad position, as a hundred yards beyond the land dips down into a swamp, where mosquitoes breed in great numbers. The first three weeks of my stay I was not troubled by these insects, but near the end of my visit they became troublesome. Fever is bad from January to May, the natives of the island of Babba, of whom a number live in Watidal, being more susceptible than the natives of Tenimber.

The first ten days of my stay was spent in getting over the country in search of sugar cane. Unfortunately at this time of year there is only young cane and rattoon roots. The latter were badly attacked by borer. I soon discovered that the chief habitat of these insects was the sago and pinang (or betel nut) palms. In these they existed in hundreds. In the former they live in the base of the leaf stalks, especially those that have been cut down; sometimes they go right up the leaf stalks. In pinang they get into the soft centre of the tree. One old pinang palm I cut was infested from root to crown, some forty to fifty feet, and must have contained thousands of empty cocoons. I examined hundreds of these, but from all the beetles had issued in the orthodox manner. For larvae it was necessary to cut into the sago palms. There are two species in Larat; one has smooth leaf-stalks, while in the other the leaf-stalks are covered with long strong spines, which are brittle at the tips and break off in the flesh. After the rains commenced, working in the sago meant standing in ten inches of water. Mosquitoes used to often drive me away, even when I had my head covered with a net. Eggs were very difficult to obtain, either in the field or in my breeding jars. I only handled about one hundred and fifty all the time I was in Larat. I placed these in suitable spots exposed to any parasites that cared to visit them, but they all hatched out larvae. I bred out many pupae, and took many larvae back to Amboina with me. I must have examined a couple of thousand empty cocoons. All this material produced no parasites. In captivity several things attacked them, but a small Histerid was the only thing I observed in the field. Fungi at times attack the adults. I took some Histerids and fungi away with me, and hope to be able to forward some to Honolulu before long.

When I speak of this beetle as *S. obscurus* I do so with reserve. Evidently it is the one procured by Forbes and identified as such, but it is a variety distinct from our Honolulu specimens. The dark mark on the thorax is much greater and the markings on the elytra are more distinct and of greater extent. The punctures on the thorax may be slightly coarser also. But these are all points that vary greatly, even in our Honolulu specimens.

The state of things did not allow of my staying longer, although I should have liked to have done so, for insects, very scarce when I first arrived, became more abundant after the rains started.

The natives I found easy people to get on with, in spite of reports I heard to the contrary. In my trips to Jamdena I generally took a native of Watidal as a guide; sometimes Mr. Sigers came with me. In going about in Larat I often went by myself, or with only my own boy.

I had previously read of the platforms erected for the dead, but I noticed that all the detached rocks round the coast were used as resting places for the coffins. These are often a canoe cut in half, one-half being used as a cover. More modern ones I noticed were made out of Devo's petroleum cases.

The whole group is very low land, Laibobar, 800 feet, being about the highest point. The spots I visited in Jamdena were away from any village and consisted of thick forest. Around the villages in Larat there is little large timber, as the system of cultivation, similar to that in Borneo, soon clears it away. When the land is cleared for sowing their maize, fruit trees are allowed to remain. Hence one sees large old bread fruit trees growing in the midst of secondary forest growth.

The soil is a rich loam, with coral cropping out all over the island. The soil is fertile and vegetation very quick in growing. The aspect of the country upon my arrival, when all vegetation looked dry and dusty, and a month later, when the rains had started, was a great contrast.

Wild buffalo are numerous in Jamdena, which made one keep a sharp look out, when collecting. I only saw one, but their spoors were numerous along the sand.

On the 3rd of January I said goodbye to my friends of five weeks and returned to Amboina.

The above was written at sea after leaving Larat. Upon my arrival in Amboina I found a letter from Dr. Perkins awaiting me, in which he gave the results of his investigation in London.

Larat, Kei, Dulan, and Gambier Islands are given as the habitat of *S. obscurus*. The Kei group, to the northeast of Tenimber, is not likely to be an improvement on Larat. Up to the present I have been unable to locate Gambier Island. A near ally of our borer (*S. tincturatus*) is mentioned as from Macassar, Batchian and Mysol. I therefore decided to proceed to the Batchian and study this species.

For several days after my return I was busy indoors in packing and arranging for my next trip, and going round to get information about Batchian. When I was at length free, I visited a clump of sago palms in which I had spent many an hour before going to Larat. With the knowledge gained in Larat I set to work again, and in an hour's time came upon an empty *Sphenophorus* cocoon. Further search revealed three specimens of a beetle, that I now consider to be *S. obscurus*. With the exception that the dark markings are of greater extent, it agrees with the Larat specimen. If the latter be *S. obscurus,* then this must also be that species. Further material has shown me that the Amboina specimens vary in markings, one being quite identical with the Larat type. The two species that I take to be *S. sordidus* and *S. ferrugineus* are quite distinct, their tibia being smooth and cylindrical, while *S. obscurus* has rows of hairs down the tibia, giving them a ridged appearance.

APPENDIX E.—Printed in the Hawaiian Planters' Record, August, 1909.

Report on the Sugar Cane Borer in the Moluccas.

By F. Muir.

During my first visit to the Island of Amboina, I failed to discover the sugar cane borer; but upon my return from the Tenimber Islands, with the knowledge of the habits of the insect gained there, I soon found that this insect had similar habits in Amboina, living in sago and, very rarely, other species of palms. In the Tenimber Islands the borer was very numerous and did much damage to the sugar cane and various palms; but in Amboina it was not common, its numbers being kept down by several death factors.

Had I discovered this beetle during my first visit to Amboina, it is possible that I should not have identified it as the same as the Hawaiian species (*Sphenophorus obscurus*), as its color is so much darker, and it seldom attacks anything else than sago palms. The Hawaiian variety is very light in color, the dark markings consisting of a thin line on the thorax and some on the wing-cases. In Fiji many specimens are slightly darker and the punctuation sometimes a little coarser; in Larat the majority are much darker, the dark marks forming a ground color with light marks upon it, but some are as light as Fijian specimens; in Amboina (especially) and in Ceram the dark variety predominates, the lighter Larat variety being rare. Apart from the color there appears to be no distinction between these varieties. It is interesting to note that this color variety coincides with moisture, Amboina, with its moist climate and luxuriant tropical growth, having the darkest variety, and Hawaii, with its much drier climate, the lightest.

The chief death factors acting on the borer in Amboina are two predaceous beetles, a Histerid and an Elaterid, and a Tachinid fly. The first, a small flattish, shining black beetle, is likely to be the better predator, as both in the larval and imago stages it feeds upon the borer larva; it is hard, can stand long fasts, and, in both stages, is active. It lays single eggs in the vicinity of the borer larva, and when food is short will feed upon young leaf-hoppers and other insects. Should it take to our cane-fields it must have an effect on the number of the borer. The Elaterid in the larval stage feeds upon the borer larva and pupa; it is hardy and can stand long fasts. Unfortunately both these predators are slow breeders or their value would be very much greater.

By comparing the number of pupae with the number of one-fourth-grown larvae in a given area. I tried to arrive at an approximate estimation of their combined value. The proportion stood as one to six, which gives a death rate of about 83 per cent. The major portion of this is due to the two abovementioned causes, but it includes some other causes; on the other hand, the predators will kill off many larva in their very early stages, thus accounting for these unspecified deaths. This is but a rough estimation, but it will give some idea of the value of these death factors under favorable conditions.

The third death factor is a Tachinid fly, the young of which enter the borer larva and kill it just before it pupates. At times there is only one parasite in a larva, at others as many as eight—an average would be about three. The value of this parasite as a death factor varies, according to the condition of the sago palms, from 25 to 90 per cent.

The sago palm is one of the two trees of greatest economic importance throughout the Moluccas. The stem supplies the chief article of food, and the leaves and leaf-stalk the materials for walls and roofs of the wood-frame buildings used, since the great earthquake of ten years ago, by both Europeans and natives. The leaves are used for thatching and the leaf-stalks, called "gaba gaba," when cut and dried, are placed side by side to form the walls. Gaba gaba is generally cut from young trees and the exposed surfaces of the stumps, which are often irregular and split, form ideal homes for the borer-beetles to live and breed in. In such localities the Tachinid fly only affects some 25 to 30 per cent. of the pupae and the predators are predominant. This is the condition one finds round the town of Amboina and the larger Kampongs, but in the less populated districts very little gaba gaba is cut, and so the beetle has to pierce the stem and lay its eggs; and the young larvae feed near the surface of the leaf-stalk. In such circumstances there are no congenial hiding places for the predators and they are very scarce, but the Tachinid fly thrives and kills off as many as 90 per cent. of the borer and in consequence is very rare. This is more like the conditions we should have if we can establish this fly in our sugar cane fields. It is for this reason that I have decided to make every effort to breed this fly in borer living in sugar cane and introduce it into our islands.

In Amboina, sugar cane is only grown in small patches in the native gardens for eating, and only on two occasions did I find clumps affected by borer. In this island the natives make their sugar from the "gamontoe" or sugar palm (*Arenga saccharifera*). This palm shares with the sago palm the first place in their domestic economy; it is slightly smaller and more slender than the sago palm, the leaves are much darker in color and harder. The small mid-ribs of each leaf are tied up in bundles and serve as brooms, or when in small bundles as mosquito or fly switches. The bast at the base of the leaf-stalk is composed of strong black fiber and is used to make into rope, hard and rough to the hand, but very strong; it is used considerably by fishermen, as it stands the water very well. The base of the leaf-stalks and the trunk of the palm are covered with a felt-like coat which is scraped off and used for caulking boats and is highly prized. The sap of the palm, called "segairu," is the common drink of the natives. When fresh it is a most refreshing drink when one is hot and tired after tramping in the hills, especially when pieces of "bitter wood" (the root of a large forest tree) have been placed in it; when fermented it is intoxicating and the taste is disagreeable to most Europeans; a clear spirit that is distilled from it, is like strong gin. The sap is drawn from the male flower stalk, which grows beneath the female flower stalk and looks like large bunches of young dates. The flower stalk is slightly bruised with a wooden mallet and a fine cut with a sharp knife made in the bruised part, a bamboor, or pail of sago palm bark, hung below to catch the sap. A very thin slice is cut away each day to keep a clean exposure. From a good tree three or four gallons per day can be drawn off, and the flow will continue for ten or twelve weeks. This sap is boiled down in large open Chinese cast-iron pans, and makes a soft brown sugar with a very pleasant flavor. This sugar made into syrup with cocoanut milk is eaten with sago, and forms a common article of food with the natives; it has a pleasant burnt taste, and I partook of it daily when in Ceram. Some travellers seeing natives eat this called it "an awful mess," and were surprised when I told them that they had eaten it in the Hongkong Hotel, under the name of "Gula malacca" (gula = sugar), where it is served once a week and greatly appreciated.

The instruments for working these two palms, and the methods employed, form the most interesting and ingenious feature in connection with the natives of the Moluccas. They form a good demonstration of the fact that the complexity of civilization depends upon the variety of materials obtainable, and that is why, in past ages, the great centers of commerce became the centers of complex civilization. Three hundred years of contact with Europeans have affected these people very little, for their domestic economy has remained unchanged.

During my eight months in Amboina (January to September, 1908), I made several short trips to the less populated parts of the island to investigate the condition of the borer in places where little or no gaba gaba is cut, otherwise my time was entirely taken up in getting together parasites for shipment to Mr. Terry in Hongkong; in all I forwarded eighteen cases. From April to August it was very hard to get enough material together for shipment, as the rains were very heavy and the sago swamps bad to work in. Without the help of my Javanese collector, I could not have succeeded.

The two beetle-predators carried through in good condition, but each mail brought me nothing but disappointment regarding the Tachinid fly, till at last, in September, acting upon advice from Honolulu, I got together as many parasites and hosts as I could and took them to Hongkong myself. I was fortunate in making a good connection at Macassar and arrived in Hongkong in thirteen days; but in spite of every care I could give them, they all died off the day before I arrived, and no more hatched out subsequently.

I tried many methods for getting this fly alive to Hongkong, but I did not like to use too many for experiment purposes. I tried breeding them in borer in sugar cane, but as I could not get my artificial conditions to their liking I got only one larva parasitized. There remained only two things to be done in connection with it,—either to find it living in nature in the *borer in sugar cane* or to work out its life-history, and try to establish suitable conditions under which to transport it. I therefore suggested that I should return to the Moluccas and continue my researches; first, in the hope of finding some further parasite; and secondly, to work out the life-history of the fly and try some new method of transportation.

The Director and Committee having agreed to my suggestion, I left Hongkong for Ceram in November in company with Mr. J. C. Kershaw, with whom I had traveled in China in 1906. We had to wait nearly a month in Amboina for a mail boat, and as I could get no definite information as to a likely spot to go to, I took the opportunity offered me by the Resident of Amboina to accompany him to Amahai and Piroe in the government boat. Finding Piroe would be a suitable spot, I arranged through the kindness of Mr. Koester, the Controleur of West Ceram, for the use of a house belonging to one of the officers then in the mountains with an expedition against the natives. It was only a two-roomed wooden house, but it had a good roof and a cement floor and so was dry. A week later I returned by mail boat with my boxes and settled down for a couple of months.

The island of Ceram is exceedingly mountainous, some of the peaks rising from seven to eight thousand feet, and covered with forest. In many places the mountains come down steep to the sea, and nowhere is there extensive flat-land. As one sails along the coast the mountain sides present one uniform green surface, a splash of red or yellow showing where a large forest tree is in flower. Many streams come down from the mountains and in their lower part spread out into swamps, especially where the hills stand back a bit from the coast. The majority of the trees on the lower ground differ from the mountain species and grow to a larger size. Piroe is situated at the head of the bay of that name, which runs north and nearly cuts the western part off from the rest of the island; this western portion is often called "Little Ceram." The distance across to the northern coast is not great, and the hills are lower and stand back from the coast, consequently there are extensive flat swamps in this district, which is the home of the sago palm. From this district sago is shipped to all parts of the Moluccas.

In Amboina the sago swamps can be considered as cultivated, as the intermediate growth is kept cut and cleared; but in Ceram it is very different, the swamps being in a natural state of growth. Many other species of trees grow among the sago palms, and thick undergrowth and creepers make it impenetrable, unless one keeps to the few paths made by the sago cutters or cuts a path for oneself; most of the time one is up to one's knees in water and mud.

Unfortunately I arrived at the latter end of the wet season, and, excepting the first week, when there was a break in the rains, had heavy daily rains. Never one day did I come home dry, on most days returning soaked from head to foot, and often spending hours in water nearly up to my knees.

Directly one left the low land and began to ascend into the hills the nature of the soil and vegetation changed. Tall forest trees and many species of palms, among which one could walk with comparative ease, made a delightful change from the swamps. A slender tree from fifteen to twenty feet high and one to two inches in diameter was common in places, and ferns like bracken were common where the trees had been cleared. Several handsome palms that grew in the forest would make good additions to our ornamental palms in Honolulu. Orchids were scarce in the forest—a fact that surprised me. Most of the trees in the mountain forest are high, but not of great girth, a condition no doubt due to the heavy rains and great heat. The gum dammar tree is common all over this district. It is in rotten stumps and logs in this country that *Peripatus* lives.

Being by this time well acquainted with the habits of the borer, I soon found it in the Ceram sago palms, but not in any great quantity. Owing to the nature of the country, I had to work most of the time in the vicinity of the native sago washers, as theirs were the only paths. The conditions were about the same as in Amboina, the two beetle predators being rather rare, the Tachinid fly fairly common. Out of 537 cocoons examined, 313, or about 58%, were attacked by the fly. When we consider that most of my cocoons were collected where gaba gaba had been cut, or the leaf-stalk cut for clearing purposes, this percentage is high. When I confined my attention to spots where no cutting or clearing had taken place, the borer was very scarce, and the percentage of cocoons attacked rose to nearly 90%. It is quite *possible* that there is an egg parasite, but eggs were so hard to procure that I failed to get it. In most insects one can see by the old egg-shell if it has been attacked by parasites, but in the case of the borer this cannot be done, as the shell is so thin that it entirely collapses when the larva hatches out. I tried to get beetles to lay in the ends of the stumps in the field by placing wire cages over them, but with small success. Even when the mesh of the wire is of ample size for the parasite to pass through, it is quite possible that it would not do so.

The conditions existing in Ceram further convinced me that it would be best to find a spot where this fly attacks the borer in sugar cane, so I decided to proceed to British New Guinea, where the borer exists in sugar cane and most probably the parasite also.

I was surprised to find that in Piroe the natives do not make sugar from the sugar palm, although it is very common and used for all other purposes, but import it from Amboina; however, they make sugar, or at least a thick syrup, from the sugar cane. To do this they place a flat stone in the center of an iron pan and, with another stone held in the right hand, beat up the cane as it is held on the lower stone with the left hand. This is boiled down, but I never saw it in any state but a thick syrup. The results are so small compared to what they could get from the sugar palm, that it is surprising that they should select the sugar cane.

To return to Amboina by the mail boat I should have had to take a seven or eight-day voyage across to New Guinea and back, so I decided to go across in a native boat. Mr. Koester kindly arranged for a boat to come up from Kaibobo; it was of a type that is often used here for going around the islands, and consists of a heavily-built boat with a cabin in the center and pointed bows and stern with a couple of large oars for rudders,—a heavy boat to row and a bad sailer. I expected to take about three days, but we had exceptionally good weather and got across in one day and a half. I heard, upon my arrival, that they had had very heavy weather for some days up to a day before I started and if I had caught it we should have had to wait under the shelter of the land; fortunately, we just got the finish of it and came across nicely.

I was annoyed to find that the Australian boat no longer called at Banda, so I had to go to Macassar. During my two weeks there I made trips into the surrounding country to see the native sugar patches, but found no trace of borer. No sago is grown round Macassar, and I could not fit in a boat to go up north to see the sago there and be back in time for the Australian boat. I left Macassar on April 9, for Thursday Island, hoping there to hear of some means of communication with Port Moresby. Upon my arrival we learned that our boat had to go there for cargo, but that I should not be able to land, as Thursday Island was infected with diphtheria. I therefore took ticket for Townsville (as they would not issue one for Port Moresby), hoping to be able to land at the latter port, but if not, to go on to Queensland and return by the next boat. Upon arriving at Port Moresby the doctor told me I could land, but would have to go into quarantine, so I decided to do so. This proved to be quite a little Gilbertian episode which lasted five days. The quarantine house is a one-roomed iron place on the west side of the hill at the entrance of the harbor. A lady, Miss Grimshaw, who has travelled and written extensively about the Pacific Islands, was occupying the house at the time, so I had to sit out in the open till she moved out, when I moved in with my boxes, a few cooking pans, and some tinned meats and biscuits, to live in splendid isolation for five days. I do my own cooking and washing up, but I stroll around the house and go down to the sea and bathe. This part of New Guinea is in the dry belt and the hills surrounding the harbor are bare and dry, with a few stunted "gum" trees; they remind me of the rocky islands round Hongkong. The doctor, who is an exceedingly nice man, comes up once a day to have a yarn, but he is too busy at present to stay long. The land about eleven miles from Port Moresby has been found to be rich in copper, and there is at present a copper boom on. A lot of land is being taken up for planting, and people are living in that happy frame of mind common to those who believe in the young country they live in and expect "good times ahead." If I can get a few feet of room in the hotel when I leave quarantine, I shall be lucky.

During my travels of the last year I have made collections which will be worked out at some future date and be of interest and use to the Station. I found a new (?) species of leaf-hopper in Amboina, as well as *Perkinsiella vastatrix*. The latter was also in the sugar cane in Ceram. Parasites of the same genus, perhaps the same species, affect their eggs as in Java and elsewhere, one more proof that they are the main factors in keeping these insects in check.

APPENDIX F.—Printed in The Hawaiian Planters' Record, November, 1909.

Concluding Report on Travels in the Malay Archipelago in Search of Parasites for the Cane Borer.

By F. Muir.

My last report, written in the quarantine shed at Port Moresby, covered my landing. After five days' detention, I was allowed out of quarantine and moved down to the Port Moresby Hotel. I took the first opportunity to call upon Mr. M. Staniforth Smith, administrator and chief of the agricultural and mining bureaus, from whom I received a great deal of useful information as to the best districts to visit for sugar cane, also offers of help in every way possible. A couple of days later I was introduced to Mr. F. Rattle, an Englishman, who is experimenting with cotton growing, in the Laloki district, about fifteen miles from Port Moresby; he offered to put me up for as long as I liked to stay, and as his camp was the nearest place to Port Moresby, where I could get a fair amount of sugar cane, I gladly accepted his offer, and arranged to go out to his camp as soon as he returned from inspecting some land along the east coast. I soon found out that it was no easy task to move about in this district, unless one had "signed on" some natives, for although there were many "boys" about Port Moresby doing nothing, yet I could get no one to carry my bags, even the short distance I was going. Eventually, I was indebted to the representative of Messrs. Burns Philp & Company for the loan of half a dozen "boys" to carry my bags with clothes and a certain amount of tinned meats, etc., that it is necessary for one to take.

The road, after skirting the coast for a short distance, turns off over the low coast hills and, with many a turn and rise and fall, through a comparatively uninteresting country, strikes the Laloki river about twelve miles inland. The coast hills consist of metamorphosed limestone, and the same formation crops out all over the country up to the Astrolabe mountains at the back, an igneous formation that evidently caused the metamorphosis of the limestone. Among the outcrops are flats of greater or lesser size, of deep dark loam of a fine mechanical texture, covered with long grass, which thins out on the limestone outcrops. A stunted species of "blue gum" is scattered over the country, and a cycad is conspicuous, especially on the limestone outcrops. Until one reaches the river, where there is some large timber, the road is monotonous and hot, specially if it be necessary to walk it twice a month or so for one's mail.

As Mr. Rattle's camp is situated in the fork of the Laloki and Goldie rivers, it was necessary for me to cross over to Laloki. At present bridges in this part of the world are left to nature to construct, and generally consist of one or more large trees, washed down by the floods, getting stranded across the river. Such bridges are naturally as quickly swept away as formed, and it often happens that when you want to go into port, or get back home, you must search for miles along the bank for a bridge; also such bridges are not always the most convenient to cross, and I sometimes preferred to cross on the seat of my trousers rather than on the soles of my boots. Crocodiles are numerous in the rivers, although one seldom sees them, as their movements in the water are so noiseless for such a large and clumsy-looking animal; a twelve-foot beast will glide off a log into the water leaving hardly a ripple on the surface.

The road being unknown to me, I missed the path through the timber down to the river, and so did not reach camp until near midday.

Soon after our lunch my host took me to the native gardens in this vicinity; and before we had been there half an hour, I discovered the cocoon of our sugar cane borer, containing the puparia of the Tachinid parasite. Such quick success to my search delighted me, as I had not expected it, and immediately explained to my host how convenient to me it would be if I imposed upon his hospitality for a few months. He considerately tried to put the glove on the other hand, by insisting that my company would be very acceptable, as he was tired of having no white man to speak to for weeks at a time. A few days later, I returned to port, cabled to Honolulu to inform the Station of the satisfactory conditions and to take back some cages, bottles, etc., for breeding purposes. Again I was indebted to Messrs. Burns Philp & Company's representative for the use of "boys" to carry my boxes.

Mr. Rattle's house was a temporary one-roomed, native-built grass affair, to be substituted by a more permanent abode if his cotton experiments proved a success, and its cultivation taken up extensively. Along one side of the room was a raised platform on which we placed our camp-beds; a small camp table and chairs were the chief items of furniture. With a few billy-cans, a camp-oven, etc., one can be very comfortable, for the bush, but scientific work is restricted. For the first month we were fairly well off, as his house-boy was a good one, for a Papuan, but when his time was up we could not get another, and so had to do our own cooking and washing. This is the common thing in the New Guinea bush.

Situated between two rivers, with a swamp at the back, mosquitoes were naturally very numerous; at sunset a wood fire was lighted in the center of the room, and we turned into bed very early. In the immediate foreground, looking from the camp toward the north, was the heavily-timbered banks of the river, and beyond that one could see Mount Victoria (13,000 feet) and other peaks of the Owen Stanley range; to the east, about ten miles off, rose Homblom Bluff, about 2500 feet, and a little to the south Waiarata, about 3000 feet. In the other directions our view was blocked by the timbered banks of the river.

All this district (about 30 miles on each side of Port Moresby and extending about 20 miles inland) is the "dry belt" and, for New Guinea, has a very small rainfall. All the native gardens near our camp were from 40 to 100 yards wide, extending to various lengths along the river banks. The native trees are cut down and partly burnt; various native products, such as bananas, taro, yams, sugar cane, pumpkins and pineapples, are planted haphazard and grow at their own sweet will, which is very luxuriantly about here, as the soil is a deep, rich, river deposit. Women do most of the work in the gardens. These gardens, especially among the pumpkins, were favorite places for snakes, a large poisonous species, locally known as the "black snake," being very numerous. One I shot was over five feet long, and I saw others much larger.

The natives all through Papua grow sugar cane in their gardens, which they eat, but never make into sugar, nor do they use the sugar palm for this purpose in the districts I visited. The roots are ratooned several times and "tops" planted in patches and grow to large size. It would soon fall down and break if they did not tie it into bundles and support it by a large stick.

These large bundles of cane, dead leaves, etc., form ideal breeding places for various insects, partly secure from some of their natural enemies. The sugar cane was badly bored, but the worst pest was not our beetle borer (*Sphenophorus obscurus*), but a species of moth, nearly allied to the Striped Stemborer (*Diatraea striatalis*) of Java. There is a parasite on its eggs and a Tachinid parasite on the larva, but the latter is so heavily parasitized by a small wasp that I failed to breed any out. The second borer in importance is a small beetle (at present unidentified) that works in a similar manner to our Hawaiian beetle borer. To one used to the conditions of the borer in Hawaiian and Fijian sugar cane fields, the borer in Papua is not numerous, a day's search seldom revealing more than a score, and traps of cut cane laid down over night produced very few.

Where the borer is breeding in the sugar cane tied up into bundles, I found out of 300 cocoons 56% parasitized, but where the borer is breeding in upright single stalks the percentage, out of 200 cocoons, rose to 87%; this latter would be more the conditions the parasite would have to work under in our Hawaiian fields. These figures only represent the conditions existing in the district where I was located and during the three months I remained there; elsewhere and at other seasons of the year, they may vary very considerably.

In these matters it is always safest to be a prophet after the event, therefore I am loath to make any definite statement as to the value of this parasite when once established in these islands. In Amboina and Ceram it exists under very moist conditions in the borer larva living in sago; while in the part of Papua I worked in it exists under comparatively dry conditions in borer larva living in sugar cane. This indicates that it is very adaptable, both to habitats and climatic conditions, and should be well able to adapt itself to the conditions prevailing in our islands.

The difficulty is to get these small flies from such a distance, the shipping facilities being very poor, and great delay in transshipment being unavoidable. The best route is from Papua to Brisbane, and then by the Vancouver boat to Honolulu, but the difficulty is to avoid delay along the Queensland coast.

The method I decided upon was as follows: First, to get large colonies of borers established in healthy cane stems in the fields, then to expose them to the attacks of the parasites under natural conditions, and then transfer root and stems to my cages and bring them back. By having a stock of unparasitized borer on hand I hoped to be able to get a second generation en route should the first hatch out before I reached Honolulu.

To avoid delay I chartered a small sailing boat to take me across to Cooktown (Queensland), where I could pick up the coast boat to Brisbane. Unfortunately, this arrangement fell through, and I had to go across to Thursday Island and from there to Brisbane. Bad luck overtook me and before leaving Port Moresby I contracted typhoid fever, which compelled me to call in a doctor upon reaching Brisbane; he immediately sent me into a hospital, where I remained for over five weeks. My cages were landed and placed in the government railway shed at the docks, by permission of the Queensland Agricultural Department, and would have had to reamin there had not Mr. Claud

Musson, a gentleman in Brisbane, to whom I carried letters of introduction from Port Moresby, kindly looked after the shipping of them by the S. S. Aorangi.

Having no one to attend to them during the voyage, it was to be expected that no, or very few, parasites would arrive alive. Mr. Swezey, who handled my cages upon their arrival, informs me that over two hundred parasites must have hatched out and died en route. With the experience now gained, I think we shall succeed upon my return to Papua.

In my report upon my return from Fiji in 1906 I wrote: "It is interesting to note that with the introduction of soft varieties of cane" (Guru and Badilla from Queensland), "the borer is apparently on the increase, or at least its attacks are more severe." At that time these two soft varieties were only being grown on a very small scale. When passing through Suva on my way from Brisbane, I learnt that one had entirely gone out of cultivation owing to disease, and the other was so very severely attacked by borers that a fairly heavy wind would sometimes bring down whole fields; the continuation of its cultivation was very doubtful.

One of the most interesting things about the native sugar cane in Papua is the great number of varieties that exist. Nearly two hundred have already been collected and planted in the government gardens and more are constantly being sent from the various districts. The reason for this great number, I believe, lies in the fact that in Papua the canes seed abundantly and sow their own seed; on several occasions I found seedlings growing in the gardens. When one considers that often, off of one arrow, many varieties can be reared, it is only reasonable to suppose that in a country favorable to the natural sowing and germination of the seeds, an infinite number of varieties could be found. Many of these varieties must have been established for many years, as the natives recognize them and have given them distinct names. Several very good varieties have been introduced into Queensland and Fiji, but many, possessing various qualities that would be useful for crossing purposes, must still be unknown.

A leaf-hopper (*Perkinsiella vastatrix*) allied to our Hawaiian species is found in the sugar cane, but its numbers are kept down by parasites in the eggs, very similar to those imported into Honolulu from Queensland and Fiji. Another small light-colored hopper is also found in all its stages on sugar cane, its numbers being kept in check by similar death factors.

When I consider the numerous species of insects that I have found living on sugar cane in the various places I have visited during the last three years, some belonging to groups of which we are quite free at present, any one of which might prove as destructive as the leaf-hopper or beetle borer, I then fully recognize the necessity of keeping the strictest supervision over all imported plants and fruits.

Queensland sugar planters have introduced the Hawaiian beetle borer (*Sphenophorus obscurus*) into their fields along with New Guinea sugar cane. At present it is only in the Mossman district, and they are making efforts to stamp it out, but I doubt if they will succeed.

At present there is a big boom in British New Guinea (known officially as Papua), several large English and Australian syndicates having taken up land for tropical agricultural purposes.

The sea-island cotton, growing at Mr. Rattle's place on the Laloki, was the largest and finest I have ever seen; the bushes, although cut back when about five feet high, were eight and nine feet high, covered five or six square yards and were covered with fine large bolls when I left. Two species of cotton stainer were the worst enemies on it; the cotton boll-worm (*Heliothis armigera*) is scarce, only appearing in an odd boll or two; evidently it is kept in check by some efficient enemy, but the only one that I noticed was a wasp which would carry them off for food for its young.

Tobacco grows wild in the native gardens, the leaf often being of good size and free from spots; under proper cultivation no doubt it would do as well as in Sumatra. Para rubber and a native Ficus do well; the former is being planted on several new plantations. Sisal hemp is also being planted extensively and does well.

Land can be leased on easy condition from the government, and to a limited extent the country is sure to go ahead, but the scarcity and quality of the labor prevents it from ever becoming a second Java.

Copper has been found over a large area of the Astrolabe range, but little has been done at present to develop it. Several persons have shipped surface ore and developed far enough to prove their propositions, but have not sufficient capital to continue.

APPENDIX G.—Printed in The Hawaiian Planters' Record, October, 1910.

Report on Second Trip to British New Guinea to Obtain a Tachinid Fly Parasitic on the Sugar Cane Beetle Borer.

By F. MUIR.

I left Honolulu on the 8th of January of this year with the object of proceeding to New Guinea to fetch a supply of the Tachinid flies which destroy the sugar cane beetle borer (*Sphenophorus obscurus*) in that country. My experience last year taught me that there was very little chance of being able to bring this fly straight through to Honolulu, as they would not breed when confined in small cages on board ship. Their period of pupation, the only stage except the adult when they are visible and one is sure of having them, being only sixteen days, would not admit of so long a journey, even if the steamers all connected, a thing they seldom do in this part of the world. For these reasons we decided to establish a station in Queensland, where we could breed the flies in captivity. We were very fortunate in procuring the services of Mr. J. C. Kershaw to take care of this intermediate station, handle the material I should send from New Guinea, and continue to breed the flies after I left with my first consignment for Honolulu, so that in the event of anything happening to the first lot, we could fall back upon the Queensland station for more instead of having to return to New Guinea. Mr. Kershaw proceeded from Macao (South China) to Brisbane and met me there upon my arrival on January 22.

Mr. Kershaw and I called upon Mr. H. Tryon, the Entomologist to the Queensland government, and asked his advice as to the most suitable place to establish a breeding station in Queensland; he informed us that the beetle borer was to be found in fair numbers in parts of the Mossman district. We also wrote to the Federal authorities in Melbourne for permission for us to establish a breeding station in Queensland, to import our parasites, and arranged that my consignments of parasites from New Guinea passing through the postoffice to Mr. Kershaw should not be opened in the custom house at Port Douglas, but be sent to Mossman and opened by Mr. Kershaw in the postoffice.

On January 29 I left Brisbane for Port Moresby, and a few days later Mr. Kershaw proceeded to Mossman with letters of introduction from Mr. Tryon to several of the leading sugar planters in that district.

I arrived in Port Moresby on February 7 and found it somewhat more lively than when I left last year on account of the number of miners proceeding to, and coming from, the newly-discovered Lakukamu (or William's River) gold field. The hotel was full and men were sleeping under every available bit of roofing. I was fortunate enough to get a bed in a friend's house, or I should have had to "doss" down in the corner of a balcony. On the boat I arrived by there were about one hundred miners on their way to the Lakukamu river, so it surprised me to find a great number of miners being housed, fed, and shipped back to Queensland at the expense of the Papuan government. Many of these men had come across from Queensland without any funds and found out too late that they could not "hump their bluey" (carry their own blanket, food, etc.) to the gold field and there work their claim single-handed, as they do in Australia, but that it was necessary to procure "boys" to carry food, etc., up to the field and also to work in the creeks. The early expectations of this gold field were never realized, and before I left New Guinea dysentery was so bad among the natives that the governor closed the district against all native recruits and so closed the gold field. All the natives in Port Moresby whose fancy turned on work were already signed on for the gold field when I arrived, and I could not get "boys" to take my boxes, etc., out to the Laloki, so I made arrangements, after a great deal of delay, to be driven out in a buckboard on February 11. The road out to the river is good for New Guinea, but bad for buckboards and anything therein. A large tree blown down across the road was our worst obstacle, and as we had no tomahawk with us we had to maneuver the buckboard through the branches. It took us nearly five hours to cover the twelve miles or so to the river. After "coo-eeing" for a time Mr. Rattle's boys came down to the river and took me and my belongings across the river and up to the camp. Mr. Rattle was away at the time, but he had left me the keys of his house and put his camp at my disposal, so for one month I had only my own company and that of three natives. I soon settled down to work and found I was a little early in the season; large borer larvae were scarce and parasites still more so. By inserting all the borers I could find into a clump of cane and placing all the fly pupae around about it, I managed to get a few parasitized and send them off by post to Mr. Kershaw by the mail leaving Port

Moresby on March 18. A few of these reached him alive, but they hatched out singly and so he could not start a colony with them.

Soon after this Mr. Rattle returned and I was very pleased to have his company. I tried to get "boys" to collect borer grubs for me, but only one was any good; with his aid I managed to get together a good number of borer grubs and parasites, which I took in to Port Moresby on April 21 in hopes of leaving for Cooktown by the mail on April 22, but the boat was four days late and did not arrive until April 26 and left on April 28. On the 23rd I had an attack of fever and could keep no food on my stomach and had to go into the hospital, as even for a sound man the hotel was nearly unbearable. My "room," which I shared with another, consisted of a part of the balcony divided off with corrugated iron; a space of two feet between the end of the bed and the wall and of two feet between the beds was the extent of our room. I went straight from the hospital on board ship with fever still on me; it greatly hampered my work in Mossman, and if I had not had the services of Mr. Kershaw would have prevented the success of my work; again in Fiji I was bad and had to go into hospital for two weeks. The delay in getting away from Port Moresby lost me the mail in Cooktown, so I had to remain there five days. I tried to hire a boat to take me down the coast to Port Douglas, a distance of about sixty miles, but the weather was too bad to allow of the small steam-tug attempting to go down; and the wind being contrary, it was too uncertain to take a sailing boat. My parasites were hatching out and dying, and at one time it appeared as if I should have to return to New Guinea for more. To add to my unpleasantness, the postoffice took twenty-four hours to get a telegram to Mr. Kershaw, a distance of some sixty miles! I left Cooktown on the afternoon of May 4th and arrived in Port Douglas about 3 a. m. on the 5th. I was glad to meet Mr. Kershaw and to have his help once more. We went to Mossman by the 7 a. m. train and immediately took my cases to the chemist's laboratory at the Mossman Central Sugar Mill, where the directors had kindly allowed us to carry on our work.

It may be of interest to give a short description of this Tachinid parasite and some notes on its life-history. In size it is about the same as a common house fly with bristles on its head, thorax, and abdomen; in color it is greyish with black marks on the thorax, the abdomen being black with three greyish bands; its wings are slightly fuscous along the costal or anterior margin, and when at rest are held out slightly away from the body; its flight when in the sun among the cane leaves is quick, but after mating the female spends most of her time low down among the stalks seeking for borer holes, except on rainy and cloudy days, when many may be seen settling on the higher leaves. Among flies the method of producing young varies from the usual insect method of producing eggs, in which the embryo has not begun to develop, to the production of fully-fed maggots ready to turn into pupae. The insect under discussion is in a midway stage, as the eggs, after leaving the ovarian tubes, do not pass out into the open, but are stored up in a large uterus until the embryo reaches maturity; the mother fly then deposits these young maggots in the small holes made by the borer grubs in the cane stalks, when they immediately begin to work their way along the borer runs until they find the grub, whereupon they penetrate into its interior (most likely through the skin) and live upon its juices. The borer grub appears to be very little incommoded by these unwelcomed intruders, but continues to feed up and build its cocoon ready to turn into a pupa; but at this stage the parasites overcome it and entirely consume its fat bodies and juices, then make a hole through its skin at the end of the body and come out into its cocoon and turn to pupae. Sometimes only one parasite will emerge from a borer grub, at other times as many as eight or nine. Like many insect parasites the fly produces a great number of eggs; in one case I counted 570 fully-developed eggs in the uterus, and the ovarian tubes were also full of eggs in various stages of development.

Upon going through my material I found I had been more fortunate than I expected, for I still had eight adult flies and one hundred and twenty-five unhatched puparia, of which only eighty-three hatched out. A few days after I left Brisbane for Port Moresby, Mr. Kershaw left for Mossman with letters of introduction from Mr. H. Tryon to the leading sugar planters of the district. Every facility was given to him to enable him to carry on his work, and upon my arrival I found he had erected three large cages in the field and had them well stocked with borer grubs, also a smaller cage indoors isolated from ants. We placed the eight adult flies in the indoor cage and added ten more, as they hatched out May 6; in the largest of the field cages we placed forty-two flies, between May 7 and 13, and in the second cage twenty-nine, between May 17 and 19, after which no more hatched out; the third cage we kept stocked with borer grubs for future use. The following four weeks was a time of great suspense, and when on the 28th of May we cut into half of the cane in the indoor cage and found no parasites, our disappointment was great. One of the borer grubs from this cane, which was about to pupate, I placed in a small bottle with some trash, and it was a great relief to our feelings when, on examining it one morning, we found two parasites had issued from it. On June 8 we opened up the rest of the cane in this indoor cage and found only nine parasite puparia. This poor success showed us that our indoor cage was not suitable, most likely too small, for I had failed to breed these flies in small cages in Amboina and Papua. On the 16th and 17th of June we opened up the cane in the largest field cage (in which we had originally placed 42 flies) and found 174 borer cocoons, of which 70 were parasitized, containing in all 313 parasite puparia. On the 25th we opened up the cane in the second field cage (in which 29 flies were originally placed) and found 155 parasite puparia. These returns restored our hopes, as we could now see that our breeding station in Mossman was a success. We restocked our cages, and when I left on June 29 for Brisbane the 313 puparia out of the large field cage were hatching out; the remaining 155 I took along with me. I left Mossman very weak from fever, taking along with me two cages, one containing sticks of cane with borers probably parasitized, the other growing grass and weeds to serve as a home for any flies hatching out en route, and a glass jar containing the 155 puparia in damp moss. Although my two cages were plainly marked with my name and destination (Brisbane), they put them ashore at Cairns during the night and I had to plant grass and weeds in one of my spare cages before leaving Brisbane.

Mr. Kershaw and I had come to the opinion that the probabilities of getting many of this generation of flies alive direct from Mossman to Honolulu were very small; as the mail from Brisbane did not fit in, I therefore decided to stop over for a month in Fiji and breed a new generation there.

In Suva I was met by Mr. E. W. Fenner, general manager in Fiji of the Colonial Sugar Refining Company, who drove me out to Nausori and put me up at his place during my stay, the Rewa Hotel, in which I stayed most of the time in 1905-6, having been blown down in the last hurricane. Mr. Fenner had had a cage made previous to my arrival, but as I had given him no dimensions it was smaller than I should have liked, but I had to make use of it immediately, as my flies were hatching out and dying. I immediately stocked it with borer grubs in cane and then went into hospital with malarial fever, where I remained for two weeks. Upon returning to Nausori I found that Mr. Fenner had had a fine large cage erected near my room, which I then stocked with cane stalks and placed some 500 to 600 borer grubs into it to be ready for Mr. Kershaw when he arrived, on August 8. He had two boxes of cane with parasitized grubs, one of which he took ashore to start a new colony, and the other one he passed on to me. As the cold weather in Brisbane had retarded the hatching of the flies and there was a possibility of getting many alive to Honolulu, these, with my Fiji generation, made a fine large colony. I left Suva on August 9 and arrived on August 16 with a good colony of adult flies, which had hatched out during the voyage, and many pupae which hatched out during the following two weeks. Thus, after much wandering among the islands of the Malay Archipelago and many disappointments, I had at last landed a parasite which, if it acted in these islands as it does in its native habitat, should reduce the annual loss to our sugar industry due to the ravages of the sugar cane beetle borer. In the near future we shall be able to state what chances of success we have; until then the entomologists at the Experiment Station exist in a state of suspense.

During this trip I had little time to do any entomological work apart from that on the Tachinid fly. I found five new sugar cane leaf hoppers in New Guinea belonging to the genus *Perkinsiella;* this brings the total number of species in this genus up to thirteen, of which eight are at present undescribed; I have also three new species belonging to allied genera. Each one of these, under similar conditions, is capable of devastating sugar crops, as did our Hawaiian species some years ago, so that it is of great interest to know that all over this region their numbers are kept in check by similar egg parasites as we imported to check the increase of *P. saccharicida.* Should another species at any time be inadvertently introduced into these islands, it is not likely to do the same amount of damage that *saccharicida* did, for the egg parasites already here would at once attack it, and we now know where others can be found. Besides the Hawaiian sugar cane beetle borer, there are two others in New Guinea which do a great deal of damage, and a small shot-borer similar to the one in these islands. Diseased cane was often noticed in the native gardens very like some of our own fungus diseases, but as cane is only grown in small isolated patches, it is never very bad. The rubber boom in London during the last year has attracted attention to New Guinea, and several companies have been floated to start tropical agriculture there; rubber, coconuts, sisal hemp, sugar, cotton, and tobacco being the chief products mentioned in the advertisements of these companies. The cheapness of the land, the high quality of the soil, and the suitable rainfalls form the chief attractions. Articles in various magazines and pamphlets have been issued under the auspices of the Australian Federal Government to promote interest and attract people to New Guinea, but a lot of the information is not reliable. In one place it is stated that owing to New Guinea being an entirely undeveloped country, it was free from insect and fungus pests found elsewhere! As a matter of fact, I did not see any cultivated plant that did not have some enemy attacking it; cotton and tobacco having several, and sugar cane also a fair share. When the country is discovered where no insects or fungus pests exist, planters will rush to it. The future of British New Guinea will be checked for want of labor, as, being under the Australian government, no imported native labor is allowed, not even from the Solomon and other Pacific islands, and Papuan labor is of low quality and insufficient in quantity to develop the country to any great extent. A good deal of money has been invested in the copper mines behind Port Moresby; and if expectations are realized, it will be a great factor in the copper market in the near future.

Our Hawaiian sugar cane beetle borer is scattered over northern Queensland, but its ravages have not caused alarm, as at present it is only in isolated patches and the ravages of the "cane grub" (*Lepidiota albohirta*) overshadow it. This latter is the grub of a large beetle that feeds on the roots of the cane and totally kills off large areas. This is the worst pest they have in the sugar cane fields in Queensland and causes great losses every year in various parts of the country. Collecting the adult beetle is the chief method employed to keep it in check; lately the use of carbon bisulphide has been tried, and the use of cyanide of potassium recommended to kill the grubs in the ground.

It was very interesting to return to Fiji after more than four years' absence. One of the first things to attract my attention was the great increase in both the cane borer (*Sphenophorus obscurus*) and the banana borer (*Sphenophorus sordidus*). In my report (Notes on Some Fijian Insects, Bulletin No. 2, Entomological Series) in 1906, I wrote:

"The introduction of a harder 'variety of cane is believed, by the majority of Fijian planters, to be the chief reason of the decrease' (of the borer beetle); but if this be so it took some time to be apparent, as the hard varieties were introduced some time before the borer was noticed to have decreased."

"* * * It is interesting to note that with the re-introduction of soft varieties of cane the borer is apparently on the increase, or at least its attacks are more severe."

In one of the reports of the Colonial Sugar Refining Company, it is stated that "In 1906 the borer had made its reappearance." On one plantation 7,900,000 borers were collected in 1900. A series of tests taken to show the loss in sugar in borered cane brought to the mill gave the following results:

Badilla.				
Not borered	Purity,	93.4,	Sucrose,	16.25
Borered	“	91.7	“	15.21
Difference	“	1.7	“	1.04
Malabar.				
Not borered	Purity,	84.7,	Sucrose,	11.59
Borered	“	82.6	“	10.79
Difference	“	2.1	“	.80

Taking account only of this decline, the loss on one estate in 1908 was estimated at $12,500; and in 1909, when a larger area of Badilla was planted, at $33,500. This does not include the loss discarded in field, which is greater with Badilla than Malabar. The Goru variety from New Guinea, which they were starting in 1906, has gone out of cultivation owing to borer and fungus.

The worst disease in the Fijian cane fields is one known as "Fiji disease." I brought specimens back in formalin for our Station Museum. Mr. North has been studying this disease on behalf of the Sugar Refining Company and pointed out to me that the most constant symptom of this disease is the presence of small "galls" on the underside of the leaves and in the softer tissues of the cane tops, sometimes extending a long way down the stalk. A more noticeable character, when the disease has gone far, is the drying off of the tops and the growth of the eyes into lateral branches; sometimes the tops of these also die and give forth more lateral growths. The leaves, although still green, become somewhat brittle. Some varieties of cane suffer much worse than others, as can be well seen in the nurseries where the various varieties of New Guinea cane are growing, some rows being totally killed off, while on each side are rows of well-developed canes. This disease is spread over the whole island, but is worst on the northern side, especially on rich soils. This disease is strongly hereditary; when a stool looks perfectly healthy and the "galls" are seen on only one stalk and in very small numbers, every stalk from that root will produce diseased cane if used as "seed." The best remedy at present known is to take "seed" cane from fields where the soil is poor and containing little humus.

In cutting into cane to get borer larvae I came across many larvae of a case-making moth borer. I took this in 1906, but not in cane or bananas, but now it is very common, killing coconut trees, bananas trees, and cane. Mr. F. Jepson informed me that in coconut trees it bores into the soft "heads" and they then fall off during heavy winds; in banana trees and sugar cane it also bores into the growing point, but I was unable to discover if it attacks healthy sugar cane, as all my specimens were taken out of borered and dead stalks.

Leaf-hoppers (*Perkinsiella vitiensis*) were very numerous and the cane in many fields black with "honey-dew" fungus. It was suggested that during the "blow" last March, when 30% of the cane and nearly all the banana trees on the Rewa River were destroyed, the egg-parasites may have been swept away and so allowed the following generation of hoppers to get ahead. It is quite likely that this, and the heavy rains which followed the "blow," may have killed off the greater part of the small egg-parasites.

When I consider the number of insects that attack sugar cane in the various parts of the Pacific that I have visited during the last four years, it surprises me that we have not been invaded by them long ago and in great numbers. With the quick and direct mail service across the Pacific, the dispersal of new varieties of sugar canes from New Guinea and other countries, and the desire to procure fruits and plants from all parts of the world, the old barriers are bridged over daily. Some of the fruit flies are becoming word-wide and others that are at present confined to small areas, when once they have acquired a liking for some of the cultivated fruits, will spread to an equal extent. The "potato-bug" (*Leptinotarsa decemlineata*) is a classical illustration of rapid dispersal due to a change of food-plant; previous to 1850 this beetle fed upon *Solanum rostratum* and was confined to "the eastern slope of the Rocky Mountains, northward to the Canadian boundary, eastward into western Kansas and Nebraska, and southward into Texas and New Mexico."* Having acquired a taste for the Irish potato, it spread eastward through all the cultivated territory and in fifty years invaded the whole of the States east of the Mississippi. "* * * In this habitat it remained in stability until 1845 or 1850, when the western extension of human colonization introduced into its habitat a new factor by the addition to the flora of a new plant, *Solanum tuberosum,* which proved an acceptable food." These facts show us that we must be perpetually on guard to repel these "foes on our borders" and must not relax our efforts because one occasionally passes through our lines and establishes itself within our islands. From this point of view it is of great interest to hear that the government of Fiji intends to institute inspection of all plants, fruits, etc., going into Fiji, as those islands are our outposts aganist the Australian "cane grub" (*Lepidiota albohirta*), the moth borer (*Diatraea striatalis*) and various leaf-hoppers of New Guinea and the numerous other sugar cane pests of the Malay Islands. In a few years' time a new and formidable line of attack will be opened up, by the completion of the Panama canal, not only to foes of our sugar cane, but to foes of our own, for the faster and more numerous the mail services become, the greater chance for the malaria-bearing mosquito to reach our shores alive.

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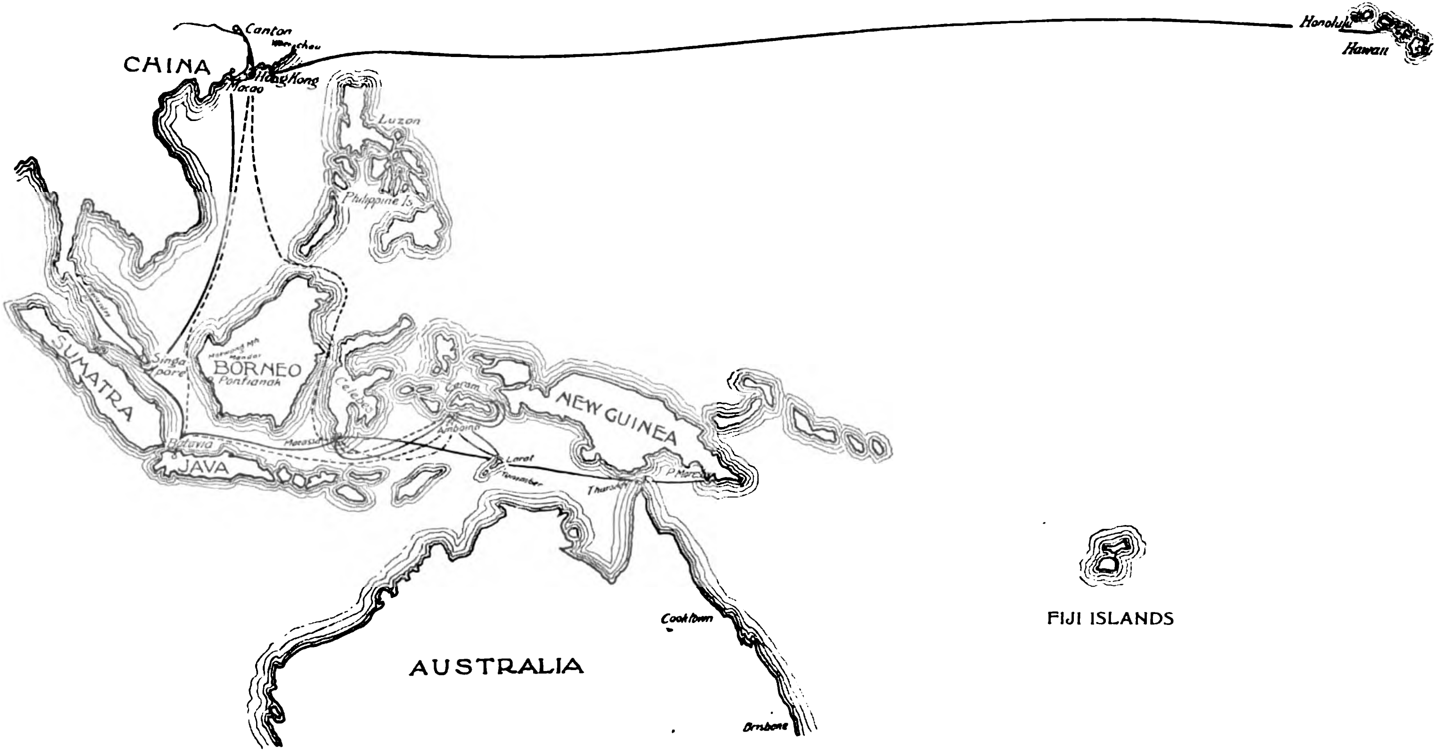
* D. L. Tower, "An Investigation of Evolution in Chrysomelid Beetles of the Genus Leptinotarsa, p. 24.



ROUTES TAKEN BY MR. MUIR WHILE SEARCHING FOR CANE BORER PARASITES.

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